Construction Safety Standards

A WATER RESOURCES
TECHNICAL PUBLICATION

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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CONSTRUCTION SAFETY STANDARDS

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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Engineering and Research Center
Denver, Colorado

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

The contents of this publication are subject to continuous review and revision as indicated by the date on the lower outside corner of each revised page. To ascertain the current status of any individual copy or obtain insert copies of revised pages, please write to the Bureau of Reclamation, Engineering and Research Center, Attn D-160, P O Box 25007, Denver CO 80225.

FOREWORD

These revised Construction Safety Standards provide the foundation for the continued growth of Reclamation's efforts toward ensuring a safe and healthy work environment for all personnel engaged in construction activities. They are the summation of the safety and health technology, regulations, and standards presently being enforced on construction activities by Reclamation, other Government agencies, State agencies, and private industry. They were promulgated in cooperation with The Associated General Contractors of America, Inc., American National Standards Institute, Society of Automotive Engineers, Inc., manufacturers of construction equipment, labor unions, and others interested in the improvement of safety in the construction industry.

In the interest of keeping these standards current with new ideas, technology, and procedures relative to construction industry safety and health programs, Reclamation continually solicits suggestions for improvement of this publication.

James E. Cook

James E. Cook
Acting Assistant Commissioner
Engineering and Research

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Section 1

PURPOSE AND SCOPE

1.1 **SCOPE.** This manual sets forth health and safety standards for all Bureau of Reclamation construction activities and operations. The standards set forth herein are consistent with the health and safety standards prevalent in the industry and those promulgated under section 19 of the Occupational Safety and Health Act of 1970, Public Law 91-596.

1.2 **PURPOSE.** The purpose of this manual is to promote working conditions and work practices which will ensure all employees a safe and healthful work environment in all construction activities administered by the Bureau of Reclamation.

1.3 **APPLICATION.** The standards and provisons set forth in this manual are applicable to all construction operations performed by the Bureau of Reclamation, its contractors, and subcontractors.

1.4 **DEFINITIONS.** When appearing in the text of this manual, the word "shall" is to be interpreted as mandatory while the word "should" is advisory. Terms such as "approved," "authorized persons," "competent person," "contaminant," "defect," "hazardous," "qualified," "safety factor," etc., appear throughout the text of this manual. Such terms shall be interpreted and convey the meaning as specifically defined in the various subparts of Title 29 CFR Part 1926, Safety and Health Regulations for Construction, and the Glossary of Terms and Definitions contained in appendix EE.

1.5 **METRIC EQUIVALENTS.** Metric conversion factors for U.S. customary (inch-pound) dimensions are provided in appendix GG.

1.6 **ACRONYMS AND ABBREVIATIONS.** Table 1-1 lists the definitions of acronyms and/or abbreviations used in this manual.

Table 1-1. - Acronyms and abbreviations

AGCA	Associated General Contractors of America
API	American Petroleum Institute
ANSI	American National Standards Institute
AWS	American Welding Society
CFR	Code of Federal Regulations
DOT	Department of Transportation
EMT	Emergency medical technician
FAA	Federal Aviation Administration
FOPS	Falling object protection structure
LPG or LP-gas	Liquefied petroleum gas
LPN	Licensed practical nurse
MSHA	Mine Safety and Health Administration
NEC	National Electrical Code
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupations Safety and Health
OSHA	Occupational Safety and Health Act
PCSA	Power Crane and Shovel Administration
PFD	Personal flotation device
POL	Petroleum, oils, and lubricants
RN	Registered nurse
ROPS	Rollover protective structures
SAE	Society of Automotive Engineers
UL	Underwriters Laboratories, Inc.

Section 2

GENERAL CONTRACTOR REQUIREMENTS

2.1 **APPLICATION.** The standards and provisions set forth herein are applicable to all construction operations performed by Bureau of Reclamation contractors and subcontractors. Provision for compliance with these standards shall be incorporated in all Bureau of Reclamation construction contracts, and in contracts of any nature requiring performance of construction, alteration, or repair work.

2.2 **OTHER CODES AND STATUTES.** In addition to the standards and requirements set forth herein, contractors and subcontractors shall comply with applicable provisions of Federal, State, and municipal safety, health and sanitation statutes and codes. In event there is a conflict between the provisions of this manual and the Safety and Health Regulations for Construction, promulgated by the U.S. Department of Labor in Title 29 CFR Part 1926, Occupational Safety and Health Act of 1970, or approved State plans, the more stringent provision shall prevail.

2.3 **SUBCONTRACTS.** Contractors shall include provision for compliance with the health and safety provisions of this manual in the terms and conditions of all subcontracts for onsite work.

2.4 **WAIVERS AND VARIANCES.** In circumstances where literal application of a provision of this manual has impractical aspects, the Contracting Officer may waive or authorize a variation to the provision. All requests for a waiver or variance shall be initiated by the contractor, in writing, directed to the Contracting Officer's representative. The written request shall include: (a) specific reference to the manual provision or standard, (b) an explanation as to why the provision is considered impractical, and (c) the contractor's proposed adaptation to the standard. The request shall contain pertinent technical data, drawings, material or equipment specifications, and other information which will enable the Contracting Office to render a decision. In each instance, however, no waiver or adaptation will be approved which endangers the health and safety of any person, is not consistent with the intent of the provisions of this manual, or would constitute a variance to Federal or State regulations. The contractor shall not proceed t waive or revise the provision until the Contracting Officer's written approval is received.

2.5 **SAFETY PROGRAM.** Within 30 days following the awarding of the contract, the contractor shall submit for approval to the Contracting Officer representative a proposed comprehensive safety program. The written program shall conform to the outline set forth in appendix CC, Contractor's Safety Program. Further, prior to the start of a major phase of work, or hazardous operation, or when requested by the Contracting Officer's representative, the contractor shall submit a plan of operations including a specific operating procedure analysis as outlined in appendix CC.

2.6 **PRECONSTRUCTION SAFETY MEETING.** Representatives of the contractor shall meet with th Contracting Officer's representative and his staff prior to the start of construction, for the purpose of reviewing the safety program and discussing implementation of all health and safety provisions pertinent to the work under contract. The contractor shall be prepared to discuss, in detail, the measures he intends to take in order t control the hazards incident to the major phases of the work under contract. This meeting will be mainly devoted to a discussion of the manner in which the contractor intends to administer his health and safety program, delegation of responsibility for implementing the program, and a determination of what shall b presented in his written safety program. Within 30 days following the aforementioned meeting, a second meeting shall be held for the purpose of reviewing the contractor's written safety program. The contractor's principal onsite representative, the general superintendent, and his safety representative shall attend this meeting.

2.7 JOINT SAFETY POLICY COMMITTEE. The Contracting Officer's representative, the contractor's principal onsite representative, and designated members of their respective staffs shall participate in scheduled monthly safety meetings. These meetings shall be used to review the effectiveness of the contractor's safety effort, to resolve health and safety problems relating to current operations, and provide a forum for planning safe future construction activities.

2.8 SAFETY PERSONNEL. When the contract does not require the services of a full-time safety engineer, the contractor shall designate a competent and dependable supervisory employee, satisfactory to the Contracting Officer, to administer his safety program. However, should the contractor's safety effort be considered inadequate, the Contracting Officer may, at his option, require the contractor to employ a fulltime, qualified safety engineer in lieu of a safety representative. Further provision is made in this manual for the use of environmental health and safety specialists where special or technical expertise is required.

2.9 SAFETY INSPECTION. The contractor shall provide for frequent and regular safety inspections of the work sites, materials, and equipment by competent employees.

2.10 ACCIDENT REPORTS. The contractor shall immediately investigate all injuries and occupational illnesses arising out of the course of employment. These incidents (first aid cases excepted) shall be reported to the Contracting Officer's representative in the manner and on forms prescribed by the Contracting Officer. Further, all accidents resulting in $2,500 or more property damage shall be investigated and reported to the Contracting Officer's representative. Contractor and all subcontractor man-hours of exposure shall be reported monthly to the Contracting Officer's representative.

2.11 **SERIOUS AND FATAL INJURIES.** All fatal or serious injuries shall be reported immediately to the Contracting Officer's representative, and every assistance shall be given in the investigation of the incident, including submission of a comprehensive narrative report, complete with witness statements. Further, other accidental occurrences with serious accident potential such as major equipment failures, contact with high-voltage lines, exposure to hazardous materials, slides, cave-ins, etc., shall be reported immediately. The contractor shall assist and cooperate fully with the Contracting Officer's representative in conducting factual accident investigations. All information and data pertinent to the investigation of an accident shall be made available to the Contracting Officer's representative. In event of a fatal accident, except for rescue and emergency measures, the scene of the accident shall not be disturbed or operations resumed until authorized by the Contracting Officer's representative.

2.12 **HOUSEKEEPING.** Good housekeeping, including provision and facilities for routine scrap removal, shall be maintained in all areas within the contractor's scope of operation.

2.13 **CONTAMINATION.** Handling, storage, use, and disposal of toxic materials of any nature shall be carried out in a manner so as not to contaminate or pollute water supplies, rivers, lakes, reservoirs, streams, or the atmosphere. Disposal of all such materials, including waste, garbage, and sewage, shall comply with Federal, State, and local regulations.

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Section 3

INSTRUCTION AND TRAINING

3.1 INDOCTRINATION

3.1.1 ***Written instruction.*** Every new employee shall be issued a written notice containing pertinent provisions of the contractor's safety program. The notice shall indicate general safety policy, and set forth procedures and regulations applicable to the work environment, reporting of injuries, and first-aid and medical care. Each employee shall acknowledge receipt of these instructions; each acknowledgment shall be filed by the contractor.

3.1.2 ***Foremen.*** Prior to initiating a job assignment, supervisors or foremen shall instruct each new employee in the recognition and avoidance of hazards incident to the employee's job assignment.

3.2 ONSITE TRAINING

3.2.1 ***Confined spaces.*** Employees required to enter confined or enclosed spaces, which may be subject to accumulation of toxic or flammable gases or may have an oxygen-deficient atmosphere, shall be instructed as to the hazards involved and precautions to be taken. Instruction shall include the use and care of necessary emergency and protective equipment such as self-contained breathing apparatus and hoseline masks.

3.2.2 ***Toxic materials.*** Employees required to handle or use poisons, acids, caustics, or other harmful materials shall be instructed in the safe handling and use of these materials. They shall be informed of the potential hazard, personal hygiene, protective equipment, and other personal protective measures involved or required.

3.2.3 ***Flammable liquids and gases.*** Employees required to handle or use flammable liquids, gases, or similar materials shall be instructed in the safe handling and use of these materials and made aware of the pertinent provisions of this manual relating to such exposure.

3.2.4 ***Harmful plants and animals.*** Employees exposed to harmful insects, plants, vermin, bacteria, or animals shall be instructed in the recognition, hazards, precautionary measures, and first-aid procedures.

3.2.5 ***Radiation exposure.*** Any activity which involves potential exposure to harmful lasers, masers, microwaves, X-rays, and electromagnetic or ionizing radiation shall be performed by or under immediate supervision of a radiation specialist. Further, persons required to be in areas of potential exposure to harmful radiation shall be informed of the hazard and required safeguards to be followed. Nuclear Regulatory Commission standards and regulations shall govern these activities where applicable.

3.2.6 ***Heavy equipment operation.*** Heavy equipment operators shall be given instruction in the saf operation of the equipment and shall demonstrate their proficiency in the operation of the equipment. Such instruction and testing shall be carried out onsite, by a qualified representative of the employer, prior to permitting the employee to operate the equipment independently.

3.2.7 ***Powder actuated tools.*** Employees using, operating, repairing, servicing, or handling powder actuated tools shall be certified by the manufacturer or his representative in the safe use and servicing of the particular tool.

3.2.8 ***Signaling.*** Employees required to give or receive signals shall be instructed in the proper use of the applicable signal system described in, or referred to by this manual.

3.2.9 ***General.*** Employees exposed to hazards such as those previously listed or engaged in hazardous occupations, i.e., diving, working on or adjacent to energized lines or equipment, firefighting, blasting, etc., shall be thoroughly acquainted with the specific hazards and instructed in the pertinent provisions of this manual relating to such exposure. The employer is responsible for such instruction together with ensuring that the employee possesses the necessary qualification, license, and/or permit required to perform such work.

3.3 SAFETY MEETINGS

3.3.1 ***Supervisors.*** The contractor shall conduct regularly scheduled supervisory safety meetings at least monthly for all levels of job supervision. An outline report containing subject matter and attendance shall be maintained by the contractor, and available for review by the Contracting Officer's representative.

3.3.2 ***Employees.*** A minimum of one "on-the-job" or "toolbox" safety meeting shall be conducted weekly by each field supervisor or foreman and shall be attended by all employees under their supervision. The contractor shall maintain a record of these weekly meetings.

3.4 FIRST-AID TRAINING

3.4.1 ***Requirement.*** Unless specifically waived or revised in writing by the Contracting Officer, every contractor foreman shall possess a current MSHA or American Red Cross first-aid certificate. A certificate attesting to completion of an equivalent 8-hour course in first aid approved or recognized by a state shall be acceptable.

3.4.2 ***Training.*** The contractor shall provide first-aid instruction in order to comply with this requirement.

3.5 SUPERVISOR TRAINING

3.5.1 ***Requirement.*** The contractor shall conduct initially and annually thereafter a 4-hour classroom review of the health and safety requirements applicable to his operations for all levels of supervision, including foremen. This manual shall be used as the text in conducting such training. The initial review shall be completed within 60 days following receipt of notice to proceed.

3.5.2 ***Bureau participation.*** A Bureau representative will be available to attend the sessions in order to assist in the training and in the interpretation of the safety standards.

3.6 DISMISSAL

3.6.1 ***Requirement.*** Should an employee refuse or repeatedly fail to comply, or supervisors fail to enforce compliance, with the safety requirements, the contractor will be requested to promptly terminate their employment.

Section 4

MEDICAL FACILITIES

4.1 GENERAL

4.1.1 ***Requirement.*** Prior to start of operations, the contractor shall arrange for prompt medical attention for injured or disabled employees in conformance with this section. Such arrangement shall provide for dependable ambulance service and services of a consulting physician for consultation on matters of emergency treatment and occupational health. All such plans or arrangements, including onsite emergency facilities and ambulance service, shall be submitted for the approval of the Contracting Officer's representative prior to start of operations.

4.1.2 ***Communication.*** Adequate and reliable means of communication on the jobsite and to the nearest medical facility shall be provided by the contractor. All employees shall be provided a positive means for obtaining assistance in emergency situations.

4.1.3 ***Signs.*** Identification and directional markers shall be provided to clearly indicate the location of first-aid and medical facilities.

4.1.4 ***Emergency lighting.*** Emergency lighting shall be provided in first-aid stations and infirmaries.

4.1.5 ***Workmen's compensation insurance.*** The contractor and all subcontractors shall provide the Contracting Officer's representative with certificates of insurance, prior to start of operations, indicating full compliance with the State workmen's compensation statutes.

4.2 FIRST-AID AND MEDICAL FACILITIES

4.2.1 ***Minimum requirement.*** Unless otherwise specified in the contract, the following are minimum contractor requirements for the establishment of onsite first-aid and medical facilities:

4.2.2 *Class A - First-aid kits*

a. On contracts or jobs where less than 100 workers are employed (total number of employees on the largest shift) and where neither a first-aid station nor infirmary is available, 16-unit (minimum) first-aid kits, approved by the consulting physician shall be provided in the ratio of one for each 25 persons or fewer employed. The first-aid kits shall be weatherproof and the contents of the kits replenished as used.

b. At least one employee qualified to administer emergency first aid shall be available on each shift and duly designated by the employer to care for injured employees. Names of employees so designated should be posted at the jobsite.

c. At least one stretcher and two blankets shall be readily available to persons designated to administer first aid.

d. A first-aid kit shall be provided when one or more employees are working in locations not readily accessible to a first-aid or other medical facility.

e. Dependable ambulance service shall be available as stipulated in paragraph 4.1.1.

4.2.3 *Class B - First-aid station*

a. On contracts or jobs where more than 99 but less than 300 persons are employed or will be employed (total number of employees on the largest shift), a first-aid station shall be established and equipped as directed by the consulting physician.

b. The first-aid station shall provide a minimum of 200 square feet of floor space with provisions for adequate light, heat, potable water, waste disposal, and ventilation.

c. Either a full-time first-aid attendant, LPN, RN, or EMT, shall be on duty in the station when work is in progress except when on emergency call. The attendant LPN, RN, or EMT shall be approved by and under the general direction of the consulting physician but in no case will the physicians approval be in conflict with requirements of this paragraph.

d. Dependable ambulance service shall be available as stipulated in paragraph 4.1.1.

4.2.4 *Class C - Infirmary*

a. On projects or jobs where 300 or more persons are employed or will be employed (total number of employees on the largest shift), an infirmary shall be established and equipped as directed by the consulting physician but in no case will the physicians approval be in conflict with requirements of this paragraph.

b. The location, size, furnishing, and equipment shall have the approval of the Contracting Officer and be constructed to provide reasonable quiet, privacy, communications, adequate ventilation, light, heat, hot and cold water, toilet facilities, and electrical outlets. The interior shall be sealed, painted, have floors of impervious material, and maintained in a clean and sanitary condition. All doors and windows shall be screened. The infirmary shall be equipped to handle outpatient treatment.

c. Ambulance service shall be available at the construction site for transporting the sick or injured.

d. The infirmary shall be attended full-time by a professional nurse or emergency medical technician approved by the consulting physician.

4.2.5 *Class D.* On projects or jobs on which more than 1,000 persons are employed (total number of employees in the largest shift), the infirmary shall be staffed by a full-time licensed physician with an adequate nursing staff. A certified para-professional may be used when a full-time physician is not available. Also, provision shall be made for short-term inpatient care and ambulance service shall be available at the construction site for transporting the sick or injured.

4.3 AMBULANCE

4.3.1 ***Requirement.*** As required by the provisions of this section, the contractor shall either provide or arrange for dependable ambulance service for the transportation of sick or injured.

4.3.2 ***Ambulance service.*** Acceptable ambulance service may be either: (a) reliable ambulance service provided by a firm or individual licensed or certified by a State regulatory agency as qualified to render such service, or (b) a standby emergency vehicle, maintained in operable condition, at the jobsite. All such vehicles shall be inspected and approved for the intended use by the contractor's consulting physician. The consulting physician shall designate or approve specific equipment to be maintained in the ambulance for the emergency care of the sick or injured.

4.3.3 ***Operators.*** Operators of ambulances or emergency vehicles shall be certified by the consulting physician, or State regulatory agency, as qualified to render first aid and to operate the vehicle in a competent manner. Such operators shall be immediately available for operation of the vehicle during all hours that work is in progress.

4.4 FIRST-AID AND MEDICAL RECORDS

4.4.1 ***Requirement.*** Contractors shall maintain current first-aid treatment and medical records. Such records shall include:

a. A daily treatment log
b. Cumulative individual injury records
c. Monthly statistical records of occupational injuries classified as to type and nature of injury
d. Required workmens compensation records

4.4.2 ***Review.*** All records referred to in paragraph 4.4.1 shall be available for review by the Contracting Officer's representative.

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Section 5

PHYSICAL QUALIFICATION OF EMPLOYEES

5.1 **REQUIREMENT.** Persons employed throughout the course of the work shall be physically qualified to perform their assigned duties in a safe manner. Employees shall not knowingly be permitted or required to work while their ability or alertness is impaired because of drugs, fatigue, illness, intoxication, or other condition that may expose either themselves or others to injury.

5.2 **MINORS.** The contractor shall comply with all Federal and State laws and codes relating to employment of minors.

5.3 **EQUIPMENT OPERATORS.** Operators of vehicles, mobile equipment, hoisting equipment, and hazardous plant equipment shall be able to read and understand signs, signals, and operating instructions. It is recommended that operators of trucks and heavy construction equipment be given physical examinations in order to determine if they are physically qualified to perform their assigned work without endangering themselves or others.

5.4 **BLASTERS AND POWDERMEN.** Blasters and powdermen shall be in good physical condition and shall not be addicted to intoxicants, narcotics, or similar drugs, and be able to understand and give written and oral orders.

5.5 **COMPRESSED AIR WORKERS.** Employees entering or working in a compressed air environment shall be examined by a physician prior to exposure and be physically qualified to engage in such work. Further, such employees are to be re-examined at least once a year and following an absence from work of over 10 days.

5.6 EXAMINATIONS REQUIRED. This manual set forth specific requirements for periodic physical examinations of designated employees in the following sections:

Section 7 - Food Handlers (paragraph 7.5.2)
Section 7 - Employee's Exposed to Radiation (paragraph 7.8.7)
Section 18 - Operators of Cranes, Cableways, and Hoisting Equipment (paragraph 18.1.6)
Section 19 - Operators of Man-Haul Vehicles (paragraph 19.5.2)
Section 29 - Divers (paragraph 29.2.2)

Section 6

EMERGENCY PLANS

6.1 **GENERAL.** The contractor's safety program shall consider and incorporate provisions for safely and expeditiously handling possible emergency situations such as: floods, fires, cave-ins, slides, explosions, power outages, windstorms, and similar catastrophic occurrences. Such planning shall take into consideration the nature of operations, site conditions, degree of exposure of persons and property, etc.

6.2 **LINE OF AUTHORITY.** The contractor shall designate and assign responsibilty for handling possible emergencies. Training shall be provided for supervisors and personnel designated to handle emergency situations such as fires, explosions, cave-ins, flooding, etc.

6.3 **EMERGENCY EQUIPMENT.** The contractor shall provide and keep in readiness rescue equipment designated to handle emergencies.

6.4 **WARNING SYSTEMS.** Systems shall be installed and tested to alert persons likely to be exposed to disaster conditions and to alert and summon firefighting or rescue equipment and personnel.

6.5 **SAFETY.** The safety of employees, the public, or property shall not be jeopardized due to the urgency to resume operations or to restore service. Emergency situations shall not relieve the contractor or his employees from the responsibility to comply with the health and safety provisions in this manual.

6.6 **COMMUNICATIONS.** Emergency telephone numbers and reporting instructions for ambulance, first-aid and medical services, hospital, fire, and police shall be conspicuously posted at the jobsite.

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Section 7

OCCUPATIONAL HEALTH

7.1 DRINKING WATER

7.1.1 ***Requirement.*** An adequate supply of potable water shall be provided in all places of employment.

7.1.2 ***Source.*** Drinking water and ice shall be obtained from sources approved by Federal, State, or local health authorities, and dispensed in a manner acceptable to the approving authority.

7.1.3 ***Portable dispensers.*** Portable containers used to dispense drinking water shall be kept tightly closed, equipped with a tap, and maintained in a sanitary condition. Water shall not be dipped from these or other potable water containers.

7.1.4 ***Containers.*** Containers used to dispense or distribute drinking water shall not be used for any other purpose.

7.1.5 ***Salt tablets.*** Salt tablets shall be provided at drinking water dispensers during periods when weather or working conditions warrant.

7.1.6 ***Cups.*** Use of common cups or glasses is prohibited. Fountain-type dispensers or one-use paper cups shall be provided at each dispenser and a waste receptacle shall also be provided.

7.1.7 ***Fountains.*** Fountain-type dispensers shall be equipped with a guarded orifice.

7.1.8 ***Nonpotable water.*** Outlets dispensing nonpotable water shall be conspicuously posted, **WATER UNSAFE FOR DRINKING PURPOSES,** on a caution sign. (Refer to section 9.)

7.2 TOILET FACILITIES

7.2.1 ***Requirement.*** Toilet facilities shall be provided at each construction jobsite in the following ratios:

Number of employees	*Minimum number of units*
20 or less	1 toilet and 1 urinal
21 to 199	1 toilet and 1 urinal per 40 workers
200 or more	1 toilet and 1 urinal per 50 workers

Under temporary field conditions, provision shall be made to ensure that not less than one toilet facility is available for men and women; unless it is a mobile crew and transportation is readily available.

7.2.2 ***Portable toilet facilities.*** When sewerage disposal systems are not available, the following type toilet facilities shall be provided unless prohibited by local codes:

a. Chemical toilets,
b. Recirculating toilets, or
c. Combustion toilets.

7.2.3 ***Design of portable toilets.*** Toilets used by male employees shall be equipped with a metal, plastic, or porcelain urinal trough. Toilets shall be designed to provide privacy and protection from weather and falling objects. Cracks shall be sealed and the door tight-fitting and self-closing. Seat boxes shall be vented to the outside with a minimum 4-inch-diameter vent, with the intake located 1 inch below the seat.[1] Toilets shall have adequate ventilation and light, and all windows and vents shall be screened.

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[1] Nominal metric equivalents are 100 millimeters and 25 millimeters, respectively.

7.2.4 ***Chemical toilets.*** Provision shall be made for routinely servicing and disposing of the sewage in accordance with Federal, State, and local health regulations.

7.2.5 ***Sanitation.*** Toilets shall be maintained in a clean and sanitary condition. Provision shall be made for scheduled routine inspection and maintenance of all toilet facilities.

7.3 GARBAGE FACILITIES

7.3.1 ***Requirement.*** Garbage shall be kept in closed fly-tight metal containers and collected not less than twice a week. Garbage and similar refuse shall be disposed of in designated areas in a manner approved by the Contracting Officer's representative.

7.3.2 ***Contamination.*** Garbage, refuse, waste materials, or sewerage shall not be allowed to contaminate lakes, rivers, reservoirs, streams, ditches, or natural drainage.

7.4 WASHING FACILITIES

7.4.1 ***General.*** The contractor shall provide adequate washing facilities for employees engaged in the application of paints, coatings, herbicides, insecticides, or other contaminants which may be harmful to the health of employees. Such facilities shall be near the worksite and furnished with cleaning materials which will remove the specific type of contaminant.

7.4.2 ***Construction camps.*** Construction camps shall be provided with washing and bathing facilities approved by the Contracting Officer and in compliance with State and local health regulations. In no event shall there be less than one lavatory for every 10 persons nor less than one shower for every 15 occupants of a barracks.

7.4.3 ***Maintenance.*** Washrooms shall be maintained in a sanitary condition; cleaned daily; and provided with water, soap, individual means of drying, and covered receptacles for disposal of waste.

7.4.4 ***Separate facilities.*** Separate washing facilities shall be provided for male and female employees.

7.5 EATING FACILITIES

7.5.1 ***General.*** Contractor's food service facilities and operations shall have the approval of the Contracting Officer and comply with the codes and regulations of the jurisdiction in which they are located. Cafeterias, restaurants, mess facilities, and related operations located on construction sites shall be established, operated, and maintained in compliance with the health and sanitation recommendations of the U.S. Public Health Service and applicable State and local regulations.

7.5.2 ***Food handler's certification.*** Employees preparing or handling food shall undergo regular medical examinations and possess a food handler's certificate issued by the State or local government authority having jurisdiction. Such employees shall wear clean clothes and show evidence of cleanliness.

7.6 SLEEPING FACILITIES

7.6.1 ***General.*** Sleeping quarters shall comply with all applicable Federal, State, and local sanitation and fire protection codes and have the approval of the Contracting Officer.

7.6.2 ***Construction.*** Sleeping quarters shall afford relative privacy with a maximum of four persons in a room. Rooms shall be adequately heated and ventilated and shall have a minimum of 50 square feet of space for each occupant.[2] Sleeping quarters shall be painted, well lighted, and have wooden or impervious floors. Doors and windows shall be screened.

7.6.3 ***Maintenance.*** Sleeping quarters shall be kept in a clean and sanitary condition with regular changes of linen.

7.6.4 ***Fire protection.*** Sleeping quarters constructed on the jobsite shall comply with the NFPA Life-Safety Code 101, and shall be restricted to one-story buildings with adequate exits. All exits shall be equipped with panic bolts and clearly indicated by **EXIT** signs. All sleeping quarters shall be protected by automatic fire detectors and evacuation alarms. The facilities shall be equipped with fire extinguishers and fire hose stations meeting the provisions of section 10 of this manual.

7.7 NOISE EXPOSURE

7.7.1 ***General.*** The contractor shall be responsible for protecting employees and the public from the effects of harmful noise levels. Such responsibility shall include provision for determining the presence of harmful noise levels and the implementation of an effective hearing conservation program when noise levels exceed the values set forth herein.

7.7.2 ***Noise levels.*** Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown below when measured on the A-scale of a standard Type II sound level meter at a slow response.

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[2] Metric equivalent is 4.65 m^2.

Table 7-1.—*Permissible noise exposures*

Duration per day, hours	*Sound level, dBA, slow response*
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

7.7.3 ***Varying noise levels.*** Exposure to different noise levels for varying periods of time shall be computed by the following formula:

$$Fe = \frac{T_1}{L_1} + \frac{T_2}{L_2} + \ldots + \frac{T_n}{L_n}$$

where: Fe = equivalent noise exposure factor
T = period of noise exposure at any essentially constant level
L = duration of the permissible noise exposure from table 7-1.

If the value of Fe exceeds 1, the exposure exceeds permissible limits. All on-the-job noise exposure equal or greater than 90 dBA shall be used in the preceding calculation.

7.7.4 ***Measurement.*** Sound levels shall be measured by qualified personnel using a sound level meter which meets current ANSI S1.4, "Specifications for Sound Level Meters."

7.7.5 ***Periodic monitoring.*** In areas where noise levels could present a hazard to employees or others, the contractor shall provide for periodic monitoring. Monitoring shall be conducted by trained personnel and the Contracting Officer's representative is to be informed of the results.

7.7.6 ***Employee exposure.*** Insofar as practical, exposure to excessive noise shall be eliminated by administrative and/or engineering controls.

7.7.7 ***Hearing conservation program.*** When sound levels exceed those set forth in table 7-1 and administrative or engineering controls are not practical or effective, the contractor shall promptly initiate and carry out a hearing conservation program incorporating the following minimal provisions:

a. Audiologist. The contractor shall employ the services of a recognized audiologist to serve as a consultant in establishing and carrying out an effective hearing conservation program.

Exceptions to this subparagraph may be granted by the Contracting Officer's representative.

b. Education. Employees shall be informed of hazard areas and shall be instructed in the proper use and maintenance of ear protectors.

c. Ear protection. The contractor shall provide exposed personnel with ear protectors meeting the specifications of ANSI S3.19. Ear insert devices shall be fitted or determined individually by a qualified person.

7.8 IONIZING RADIATION

7.8.1 ***Requirement.*** Prior to the initial use or operation of a radiation machine or the storage, handling, or use of radioactive material, the Contracting

Officer's representative shall be notified. The written notification shall include the proposed location, the nature and scope of the operations, and the health and safety precautions to be taken.

7.8.2 ***Exposure.*** Radioactive materials shall be stored, handled, used, and disposed of in accordance with the controls and precautionary procedures prescribed in the US-NRC's (U.S. Nuclear Regulatory Commission's) "Standards for Protection Against Radiation," Title 10, Code of Federal Regulations, Part 20. In no event shall employees be exposed to radiation levels exceeding the permissible limits set forth in the referenced regulation.

7.8.3 ***Supervision.*** Operations involving radiation hazards shall be performed only under the direction of a qualified radiation specialist responsible for the health and safety of the employees engaged in the operations and for compliance with radiation protection standards. Only persons licensed or under the direction and supervision of the licensee shall handle materials under NRC license.

7.8.4 ***Dosage.*** Determination of radiation dosage received by persons and the degree of hazard present shall be based on the standards published in the US-NRC "Standards for Protection Against Radiation-Basic Radiation Protection Criteria." The dose for an individual shall be considered to include all doses from both internal and external sources and from all types of ionizing radiation to which he is exposed.

7.8.5 ***Records.*** Dosimetry shall be maintained for all individuals exposed to radiation in amounts of one-fourth the permissible limits and for all individuals who enter areas of high radiation. Records shall be maintained of exposure of individuals to radiation in such a manner that cumulative exposure can readily be determined.

7.8.6 ***Instruments.*** Instruments and dosimetry devices shall be approved types designed to detect and measure cumulative dosage of the type to which personnel are exposed.

7.8.7 ***Physical examination.*** The contractor shall provide initial, periodic, and termination physical examinations performed by licensed physicians under direction of radiation protection authorities. Evidence to this effect shall be maintained onsite. All cases of overexposure and/or suspected ingestion or inhalation shall be immediately referred to a physician.

7.8.8 ***Transportation.*** Transportation of radioactive material shall be in compliance with the requirements of the Department of Transportation.

7.9 NONIONIZING RADIATION

7.9.1 ***Qualified personnel.*** The installation, adjustment, and operation of laser equipment shall be performed by competent personnel trained in the use of lasers. Proof of qualification and training shall be in the possession of the operator when operating laser equipment.

7.9.2 ***Eye protection.*** Individuals working or entering areas in which a potential exposure to direct or reflected laser light exceeding 0.005 watts (5 milliwatts) shall wear laser safety goggles which will provide protection for the specific wavelength of the laser and be of an optical density adequate for the energy involved. Specifications covering optical density, attenuation factor, and design of laser eye protection is set forth in section 8 of this manual.

7.9.3 ***Warning signs.*** Areas in which lasers are used shall be posted with standard laser warning signs. (Refer to section 9 of this manual.)

7.9.4 ***Beam shutters.*** Beam shutters or caps shall be used or the laser turned off when laser transmission is not being performed. When left unattended for extended times such as lunch period, shift changes, etc., the laser shall be turned off.

7.9.5 ***Deflectors.*** Only mechanical or electronic devices shall be used as deflectors for guiding the internal alinement of the laser.

7.9.6 ***Beam location.*** Revolving laser units shall be operated only above or below the eye level of individuals unless the area is inaccessible to persons and posted accordingly. The laser beam shall not be directed at individuals.

7.9.7 ***Weather conditions.*** Wherever possible, lasers shall not be used when it is raining, snowing, or there is dust or fog in the air. In any event, individuals shall be kept out of range of the source and/or target areas during these conditions.

7.9.8 ***Labeling equipment.*** Laser equipment shall bear a label indicating the manufacturer, maximum output, and beam spread.

7.9.9 ***Light intensities.*** Individuals shall not be exposed to light intensities exceeding:

a. Direct starting - 1 microwatt per square centimeter (1 $\mu W/cm^2$)
b. Incidental observing - 1 milliwatt per square centimeter (1 mW/cm^2)
c. Diffused reflected light - 2.5 watts per square centimeter (2.5 W/cm^2)

7.9.10 ***Microwaves.*** Individuals shall not be exposed to microwave power densities in excess of 10 milliwatts per square centimeter.

7.10 GASES, VAPORS, FUMES, DUSTS, MISTS, OXYGEN DEFICIENCY

7.10.1 ***Requirement.*** The contractor shall review all operations, materials, and equipment for the purpose of determining if toxic gases, vapors, fumes, dusts, or mists may be released into the working environment. If it is determined that such atmospheric contaminants may be released into areas where persons are employed, the concentrations of the contaminants shall be brought within safe limits by design and engineering controls, such as ventilation, filtration, or installation of exhaust systems. (Refer to the latest edition of "Industrial Ventilation," published by the American Conference of Governmental Industrial Hygienists.) When contaminants cannot be adequately controlled by design and engineering methods, the contractor shall develop a specific operating procedure providing equivalent protection. The operating procedure shall be submitted to the Contracting Officer's representative for approval prior to commencement of the activity. Acceptable safe limits for contaminants are those recommended in the latest edition of "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment," published by the American Conference of Governmental Industrial Hygienists.

7.10.2 ***Additional criteria.*** In addition to the general requirements set forth in this section, this manual includes detailed requirements for specific operations and exposures, i.e., tunnel excavation; material handling, storage, and disposal; fire protection and prevention; etc.

7.10.3 ***Industrial hygienist.*** Where operations involve exposure to toxic airborne contaminants on a daily basis, i.e., tunnel excavation, extensive coating application in confined spaces, etc., the contractor shall provide for the services of an industrial hygienist to formulate a control program and periodically check its effectiveness. The control program must be approved by the Contracting Officer's representative prior to the start of the operation.

7.10.4 ***Engineering controls.*** Proposed design and engineering controls, i.e., ventilation, filtration, and exhaust systems must be approved by the Contracting Officer's representative prior to the acquisition and installation of the equipment. Drawings and design specifications shall accompany the request for approval.

7.10.5 ***Testing.*** The contractor shall provide approved testing devices for determining concentration of toxic and flammable gases, fumes, dusts, and oxygen deficiency. Determination of the concentrations and hazard from the contaminant shall be made by a qualified analyst; during initial start of operation and at least once each shift thereafter. Records of tests shall be maintained and be available to the Contracting Officer's representative.

7.10.6 ***Periodic verification.*** The efficiency of the control system, equipment, devices, and methods shall be checked and verified periodically. Control systems shall be operated continually during operations where persons are exposed to airborne contaminants or flammable gases.

7.10.7 ***Maintenance.*** Exhaust systems and air cleaning equipment shall be designed and installed in a manner facilitating routine maintenance and the removal of dust or other collected material without contaminating the general atmosphere.

7.10.8 ***Disposal.*** Toxic materials removed by exhaust systems or other methods shall be disposed of in a manner that will not create a hazard to other employees or the public.

7.10.9 ***Portable equipment.*** Airborne contaminants exceeding acceptable safe limits created by portable equipment such as saws, drills, and grinding machines shall be effectively controlled at the source.

7.10.10 ***Asbestos.*** Where employees are exposed to airborne asbestos dust, the requirements of 29 CFR Part 1910.1001 shall apply.

7.10.11 ***Oxygen deficiency.*** Employees shall not be permitted to enter or to work in atmospheres containing less than 20 percent (by volume) of oxygen unless provided respiratory protection as specified in paragraph 8.4.4.

7.11 LIGHTING

7.11.1 ***General.*** Offices, shops, storage areas, accessways, and construction areas shall be adequately lighted in accordance with paragraph 7.11.6.

7.11.2 ***Entering and exiting.*** Where artificial lighting is installed, it shall be used to provide adequate lighting when employees are entering or exiting the area.

7.11.3 ***Inspection and maintenance.*** Artificial lighting circuits shall be inspected regularly and defective lamps replaced.

7.11.4 ***National Electrical Code.*** All electrical facilities shall be installed in conformance with the latest edition of the National Electrical Code and maintained in good condition.

7.11.5 ***Fire and explosion hazard.*** Explosion-proof lighting and electrical systems shall be used for artificial illumination in areas where flammable liquids, vapors, fumes, dusts, or gases constitute a hazard. Electrical equipment installed in such areas shall be explosion-proof-type as listed and approved by the Underwriters Laboratories, Inc., or a similar authoritative organization. Electrical installations in the areas shall also conform to the requirements of the National Electrical Code relating to hazardous locations. Portable lighting devices including hand lamps, cap lights, and flashlights shall be approved as safe for Class I hazardous locations, in accordance with NFPA No. 493, "Standard for Intrinsically Safe Apparatus for Use in Class I Hazardous Locations and Its Associated Apparatus."

7.11.6 *Minimum illumination intensities for construction operations*

Table 7-2.—*Work area lighting intensities*

Application	*Lighting intensity (footcandles)*
Accessways, indoor	5
Accessways, outdoor	3
Automotive service	30
Concrete placement	5
Construction - indoor area lighting	10
Construction - outdoor area lighting	5
Excavation and fill areas	3
Exitways	5
Field maintenance, outdoors	5

Table 7—2. *Work area lighting intensities (Continued)*

First-aid stations, infirmaries, and offices	**50**
General construction plant and shops	**10**
Mechanical and electrical equipment rooms	**10**
Refueling areas	**5**
Shops:	
Fine work	**30**
Other work	**10**
Storage areas - active indoors	**10**
Storage areas - active outdoors	**5**
Toilets, washrooms, and locker rooms	**10**
Tunnels and shafts:	
Accessways (all nonwork areas)	**5**
General work areas	**5**
Active headings	**10**
Welding	**30**

Notes:

(1) For areas or operations not covered above, refer to ANSI All.1, "Practice for Industrial Lighting."

(2) In addition to providing required minimum illumination intensities shown above, consideration shall be given to the selection and placement of lighting equipment which will reduce glare, eliminate dark shadows, and provide safe and efficient maintenance.

(3) To convert footcandles to the metric unit of measure for light intensity, the lux (lx), multiply the numerical coefficient by 10.76.

7.11.7 ***Measurement of intensities.*** Measurements shall be made with a footcandle meter possessing sufficient sensitivity that interpolation of light intensities at the lower levels are minimal. Measurements shall be made at the worksite.

7.12 INSECTS, VERMIN, AND SNAKES

7.12.1 ***General.*** Protection from exposure to insects, vermin, or snakes shall include the following controls as are necessary to eliminate or reduce the hazard:

a. Boots, hoods, netting, gloves, masks, or other necessary personnel protection
b. Repellants
c. Drainage, spraying, burning, or destruction of breeding areas
d. Smudge pots and aerosols for protecting small areas
e. Elimination of unsanitary conditions which propagate insects or vermin
f. Inoculation of exposed employees when recommended by the contractor's consulting physician
g. First-aid and medical facilities available to treat infected employees
h. Instruction in recognition and identification

7.13 POISONOUS PLANTS

7.13.1 ***General.*** In areas where employees are exposed to poison ivy, oak, sumac, or other poisonous plants, the following protective measures shall be taken as appropriate:

a. Removal or destruction of the plants
b. Protective clothing shall be worn
c. Protective ointments provided
d. Soap and water shall be available for washing exposed skin areas

e. Approved first-aid and medical facilities shall be available for treatment of infected employees
f. Immunization shall be provided for exposed employees as recommended by the contractor's consulting physician
g. Instruction in recognition and identification shall be provided

7.14 ACIDS, CAUSTICS, AND HARMFUL CHEMICALS

7.14.1 ***General.*** Handling, storage, and use of acids, caustics, and harmful chemicals or materials shall be in accordance with the manufacturer's recommendations and under supervision of a qualified person. Storage of these chemicals and products shall be in areas accessible only to authorized persons.

7.14.2 ***Disposal.*** Disposal of surplus, excess, or waste materials and containers shall be carried out so as not to contaminate or pollute water supplies, rivers, lakes, reservoirs, or streams and shall comply with Federal, State, and local regulations.

7.14.3 ***Protective clothing and equipment.*** Persons handling these materials shall wear protective clothing and use protective equipment as specified in section 8 of this manual.

7.14.4 ***First aid.*** First-aid and medical facilities adequate to effectively treat exposed persons shall be available.

7.14.5 ***Emergency facilities.*** Chemical laboratories, battery charging rooms, and operations requiring use of large amounts of these materials shall have an emergency approved-type eyewash and shower immediately available to the work area.

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Section 8

PERSONAL PROTECTIVE EQUIPMENT

8.1 GENERAL

8.1.1 ***Requirement.*** This section sets forth minimum personal protective equipment requirements and standards applicable to all Bureau of Reclamation construction activities. The contractor shall ensure availability of the equipment specified in this section for protection against occupational injury or illness, and shall ensure compliance with the regulations set forth herein. Personal protective equipment shall conform to NIOSH and MSHA standards, where applicable, as well as those in referenced American National Standards Institute publications.

8.1.2 ***Maintenance.*** Personal protective equipment in use shall be inspected daily and maintained in serviceable condition. Items of personal issue shall be cleaned, sanitized as appropriate, and repaired prior to being reissued to another employee.

8.2 HEAD PROTECTION

8.2.1 ***Requirement.*** Construction employees, supervisors, inspectors, manufacturer's representatives, and visitors shall wear protective helmets of the type specified herein, when entering or working in designated **Hard Hat Areas.**

8.2.2 ***Hard hat areas.*** Hard hat areas shall include all areas where construction work of any nature, including maintenance, or repair, is in progress. The entire jobsite with the exception of offices and parking areas shall be considered **Hard Hat Areas** and the regulation enforced by the contractor.

8.2.3 ***Posting of hard hat areas.*** Signs at least 3 by 4 feet in size[1], with the following wording shall be erected at the entrance to designated hard hat areas:

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[1] Metric equivalent: 900 x 1200 mm

CONSTRUCTION AREA - HARD HATS REQUIRED
BEYOND THIS POINT

The entry to shops, warehouses, and contractors buildings and structures shall be posted with hard hat requirement signs. The signs shall be furnished and erected or posted by the contractor.

8.2.4 ***Design.*** Protective helmets (hard hats) shall comply with the design specifications of the current ANSI Z89.1. Protective helmets worn by linemen, electricians, or employees working in tunnels, shafts, or in the proximity of high-voltage conductors or apparatus shall conform to ANSI Z89.2, "Safety Requirements for Industrial Protective Helmets for Electrical Workers, Class B." Protective helmets shall bear a manufacturer's label indicating design compliance with the appropriate ANSI standard.

8.2.5 ***Winter protection.*** Winter hard hat liners shall be provided when weather conditons warrant.

8.3 EYE AND FACE PROTECTION

8.3.1 ***Requirement.*** Employees exposed to potential eye or face injury from physical, chemical, or radiation agents shall be furnished and required to wear eye and/or face protection specificially designed for exposure.

8.3.2 ***Design.*** Eye and face protection required by this section shall comply with the standards published in the current ANSI Z87.1 "Practice for Occupational and Educational Eye and Face Protection."

8.3.3 ***Corrective lenses.*** Employees whose vision requires the use of corrective lenses, when required to wear eye protection, shall be protected by one of the following:

a. Protective spectacles whose lenses provide optical correction.

b. Protective goggles or face shields that can be worn over corrective glasses.

c. Goggles that incorporate corrective lenses mounted behind protective lenses.

8.3.4 ***Selection guide.*** Appendix A, Eye and Face Protection Selection Guide, shall be used as a guide in the selection of eye and face protection for the hazards and operations noted.

8.3.5 ***Electric welding.*** Employees engaged in electric welding operations shall wear nonflammable welding helmets with lift-front or stationary front helmets. Plano, prescription safety glasses, or flash goggles shall be worn under the helmet to provide eye protection when the helmet is raised for scaling operations. Helmet filter lens shades shall conform with appendix B, Required Shades for Filter Lenses and Glasses.

8.3.6 ***Gas-torch cutting and welding.*** Employees engaged in gas-torch cutting and welding shall wear a welding mask, weld-view or coverglass goggles, or similar goggles providing equivalent eye and face protection. The eye protectors shall be equipped with filter lenses conforming with appendix B.

8.3.7 ***Welder-helper or inspector.*** Welder helpers or welding inspectors shall wear flash goggles with a minimum lense shade of 2 (appendix B).

8.3.8 ***Laser protection.*** Persons exposed to laser beams, with an output level of 0.01 W/cm^2 or greater, shall wear safety goggles which will provide protection for the specific wavelength of the laser and be of optical density adequate for the energy involved. The following table lists the maximum power or energy density for which adequate protection is afforded by lenses of optical density from 5 through 8:

Table 8-1.—*Energy density protection*

INTENSITY	*ATTENUATION*	
Continuous Wave Maximum Power Density (W/cm²)	Optical Density	Attenuation Factor
0.01	5	10^5
0.1	6	10^6
1.0	7	10^7
10.0	8	10^8

Notes:

(1) Output levels falling between values in the above table shall require use of the higher optical density.

(2) Protective goggles shall bear a label listing the following:

Laser wavelength for which use is intended; the optical density of those wave lengths and the visible light transmission.

8.4 RESPIRATORY PROTECTION

8.4.1 ***Requirement.*** Respiratory protection shall be provided and used in accordance with paragraphs 7.10.1 and 7.10.2.

8.4.2 ***Approved devices.*** Only respiratory devices approved by NIOSH or MSHA shall be provided to persons exposed to harmful concentration of dusts, gases, fumes, mists, airborne contaminants, or for exposure to atmospheres deficient in oxygen, and be used as stipulated in the approval.

8.4.3 *Respirator selection.* Respiratory protective devices and related training and procedural regulations for specific hazards not covered by these regulations will be in conformance with recommendations contained in the latest edition or superseding standard of ANSI Z88.2, Practices for Respiratory Protection.

8.4.4 *Hazardous to life.* Areas immediately hazardous to life, due to toxic concentration of airborne contaminants or oxygen deficiency, shall be entered only by a team of two or more persons wearing self-contained breathing apparatus.

8.4.5 *Cartridge or filter-type respirators.* Employees working in atmospheres containing toxic gases, fumes, mists, vapors, or dust in concentrations exceeding the threshold limits published in the current edition of the American Conference of Government Industrial Hygienist publication, "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment" shall use respirators approved for the exposure encountered. This type of respirator shall not be used in atmospheres that are oxygen deficient or contain airborne contaminants that:

a. Exceed recommended concentrations
b. Are of high toxicity
c. Can be absorbed through the skin
d. Cannot be detected by the employee's senses

8.4.6 *Air-line respirators and hose masks.* Employees working in confined areas where high concentrations of toxic substances are present in the atmosphere, but not immediately hazardous to life, shall wear air-line respirators or hose masks. Air-line respirators or hose masks shall be worn by employees performing sandblasting, spray painting with lead based or toxic coatings, welding in confined spaces, and similar operations. Air supplied to the respirator shall be clean and free of oil, water scale, gaseous contaminants, or other extraneous matter. When compressed air is used, an approved-type regulator and suitable inline air purifying absorbent beds and filters shall be inserted in the supply line.

8.4.7. ***Self-contained breathing apparatus.*** Employees entering or working in atmospheres immediately hazardous to life, shall wear self-contained compressed-air breathing apparatus of an approved type. No employee shall enter such atmospheres unless accompanied by another person wearing self-contained breathing apparatus, unless he is wearing a safety line attended by a person wearing the same type of self-contained breathing apparatus. Employees shall be instructed and trained in the use of self-contained breathing apparatus prior to exposure to atmospheres hazardous to life.

8.4.8 ***Self-rescuer.*** Employees and others exposed to underground environments, such as tunnels and shafts, shall be provided with an approved self-rescuer device. Employees shall have satisfactorily completed a MSHA approved self-rescuer course or equivalent certified training prior to going underground. Visitors instructed in the operation of the self-rescuer and accompanied by a trained employee are exempt from this training.

8.5 HEARING PROTECTION

8.5.1 ***Requirement.*** Employees working in areas where noise levels or duration of exposure exceed those specified in paragraph 7.7.2 of this manual shall be provided with ear protection.

8.5.2 ***Hearing conservation program.*** On jobsites where employees are exposed to harmful noise levels requiring ear protection, the contractor shall initiate and conduct a hearing conservation program meeting the provisions of paragraph 7.7.7 of this manual.

8.6 PROTECTIVE CLOTHING

8.6.1 ***Welding leathers.*** Employees engaged in overhead welding or burning where severe burn hazard exists shall wear leather gloves, chrome-tanned leather chaps and coats, or combination of coats, sleeves, pants, etc., providing equal protection. Leather gloves and aprons shall be worn by employees performing routine welding and burning.

8.6.2 ***High-visibility apparel.*** Employees exposed to vehicular traffic, including surveyors, inspectors, spotters, signalmen, flagmen, and servicemen shall wear high visibility fluorescent apparel with a minimum reflective area of 400 square inches.[2]

8.6.3 ***Gloves.*** Suitable impervious gloves shall be furnished by the contractor and worn by employees handling acids, caustics, solvents, herbicides, and other toxic materials.

8.6.4 ***Rubber goods.*** Rubber gloves, sleeves, blankets, covers, and line hose shall be provided by the contractor and used by employees working on energized electrical conductors or equipment when required for the protection of the employees. Rubber goods provided for the protection of employees engaged in work on energized facilities shall conform to ANSI-J6 specifications. They shall be tested, inspected, and maintained in accordance with current ASTM standards.

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[2] Metric equivalent: 2600 cm^2

8.6.5 ***Protective chaps.*** - Protective chaps meeting current U.S. Forest Service requirements shall be worn by employees operating chain saws.

8.6.6 ***Foot protection.*** Employees engaged in work having an inherent danger to the feet or requiring special foot wear, shall wear foot protection meeting the current ANSI Z41 "Safety-Toe Footwear - Classification 75." Protective footwear, including boots and pacs, furnished by the contractor, shall be suitable for the work conditions and comply with ANSI standards. Oxfords, sandals, canvas, tennis, or deck shoes are not acceptable for construction work.

8.6.7 ***Minimum wearing apparel.*** In addition to other regulations of this paragraph, all employees will wear as minimum protection full length pants and short sleeve or t-shirt. Cutoffs, tank tops, or modified shirts, etc., are not acceptable wearing apparel.

8.7 SKIN PROTECTION

8.7.1 ***Requirement.*** Where irritants or toxic substances may come in contact with the skin or clothing, employees shall be protected by one or more of the following:

a. Protective clothing and necessary eye and face protection
b. Approved protective ointment or other remedies approved by the consulting physician
c. Emergency eye flush fountain
d. Emergency deluge showers

8.8 CONSTRUCTION SAFETY BELTS AND LINES[3]

8.8.1 ***Requirement.*** Employees working on steep slopes or otherwise subject to possible falls from heights exceeding 6 feet from adjoining level, not protected by fixed scaffolding, guardrails, or safety nets, shall be secured by safety belts and lifelines. The contractor shall provide instruction for employees in the safe use of safety belts and lines.

8.8.2 ***Lifeline anchorage.*** Lifelines shall be secured above the point of operation to at least two anchorages or structural members, capable of supporting a minimum dead weight of 5,400 pounds.

8.8.3 ***Lifelines.*** Lifelines shall be at least 3/4 inch in diameter with a minimum breaking strength of 5,400 pounds. Lifelines used for scaling operations, or exposed to cutting or abrasion, shall be 7/8-inch-minimum-diameter manila rope with a wire core.

8.8.4 ***Lanyards.*** Safety belt lanyards or "pigtails" shall be a minimum of 1/2-inch nylon rope or equivalent, with a nominal breaking strength of at least 5,400 pounds. The lanyard, whether attached to a lifeline or to a structural member, shall not permit a fall over 6 feet. When used with a lifeline, the lanyard shall be attached to the lifeline by means of a scaler's hitch, as shown in appendix D, Scaler's

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[3] Metric conversion factors for dimensions contained in this manual may be found in appendix GG.

Hitch, or by equivalent means. High-scalers shall use two independently attached 5/8-inch manila rope lanyards attached to the lifeline.

8.8.5 ***Safety belts and hardware.*** Safety belts and safety harness shall meet the design specifications published in 29 CFR 1926.104, with compliance certified by the manufacturer. Lanyard hardware, D-rings, and snaphooks shall meet the following minimum design specifications:

a. Constructed of drop forged or pressed steel, cadmium plated in accordance with Type I, Class B, plating specified in Federal Specification QQ-P-416, "Plating, Cadmium (Electro-deposited)." Surfaces shall be smooth and free of sharp edges.

b. Shall withstand a 4,000-pound tensile strength test without failure or deformation.

8.9 LINEMEN'S BELTS AND LIFELINES

8.9.1 ***Requirement.*** Linemen's body belts and safety straps shall be used when working above ground levels on wood poles, steel towers, communication towers, and other transmission line, substation, and switchyard structures.

8.9.2 ***Body belts, safety straps, and lanyards.*** Linemen's body belts, safety straps, and lanyards shall meet the design specifications published in the current revision of 29 CFR 1926.959, with compliance certified by the manufacturer.

8.9.3 ***Nonconductive rope lifelines.*** Nonconductive rope lifelines shall have a minimum diameter of 3/4 inch, a minimum breaking strength of 5,400 pounds, and shall be able to withstand an a-c dielectric test of not less than 25,000 volts per foot "dry" for 3 minutes without visible deterioration.

8.10 SAFETY NETS

8.10.1 ***Requirements.*** The contractor shall install safety nets to protect employees erecting bridges and structures where scaffolds, platforms, or temporary floors are impractical. Furthermore, when required or directed by the Contracting Officer's representative, safety nets shall be used to protect employees and/or the public exposed to hazards from overhead construction.

8.10.2 ***Net specifications.*** The mesh size of safety nets shall not exceed 6 by 6 inches. Nets shall meet accepted performance standards of 17,500 foot-pounds minimum impact resistance, as determined and certified by the manufacturer, and shall bear a label of proof test. Edge ropes shall withstand a minimum breaking strength of 5,000 pounds. Nets installed for overhead protection shall be lined with wire or synthetic netting of not more than 1-inch mesh. Wire mesh shall be not less than 22 gage; synthetic not less than No. 18 twine.

8.10.3 ***Installation.*** The net suspension system shall be designed and constructed with a minimum safety factor of four and shall withstand the test loading without permitting contact between the net and any surface or object below the net. Connections between panels shall develop the full strength of the net. Forged steel safety hooks or shackles shall be used to fasten the net to its supports.

8.10.4 ***Positioning.*** Safety nets shall be installed as close under the work surface as practical, but not over 25 feet below the working level. Nets shall extend at least 8 feet beyond the perimeter of the work area.

8.10.5 ***Testing.*** Safety nets shall be field tested immediately following installation, repositioning, or major repair. The test shall be conducted by dropping a 400-pound bag of sand, not over 30 inches in diameter, from a height of at least 25 feet, onto the center of the net.

8.10.6 ***Inspection and maintenance.*** Nets shall be inspected daily for damage, and necessary replacement or repairs shall be made before work above the net is resumed. Debris shall be removed from the nets at least daily.

8.11 FLOTATION DEVICES

8.11.1 ***Requirement.*** Type III or equivalent U.S. Coast Guard-approved international orange personal flotation devices (PFD) shall be provided and worn by employees:

a. On floating pipelines, pontoons, rafts, or float stages
b. On open deck floating plant not equipped with bulwarks, guardrails, or lifelines
c. On structures, cuts, cliffs, or banks extending over or adjacent to a water hazard, except where guardrails or safety nets are provided; or employees are secured to lifelines
d. In skiffs, small boats, or launches except when inside an enclosed cabin or cockpit.

8.11.2 ***Ring buoys.*** Ring buoys approved by the U.S. Coast Guard with at least 90 feet of line shall be installed at 200-foot intervals on worksites where a water hazard exists.

8.11.3 ***Inspection and replacement.*** At regular intervals and after each use, personal flotation devices shall be inspected for defects which would compromise their safe use. Devices found to have less than 13 pounds buoyancy or are otherwise defective shall be replaced.

8.12 LIFESAVING SKIFFS

8.12.1 ***Requirement.*** One or more lifesaving boats or skiffs, approved by the Contracting Officer, shall be provided at locations where men are working over or immediately adjacent to water where a drowning hazard exists. Persons trained in launching and operating the skiffs shall be immediately available during working hours. The skiffs shall be used only for drills and in emergencies.

8.12.2 ***Equipment.*** Lifesaving skiffs shall have the following equipment on board:

a. Four oars (two if motor powered)
b. Oarlocks attached to the gunwales or to the oars
c. One ball-pointed boat hook
d. At least one ring buoy with 90 feet of line attached
e. Two life preservers or work vests
f. Emergency lighting

8.13 OTHER PROTECTIVE EQUIPMENT

8.13.1 ***Requirement.*** Other protective equipment, fire and rescue devices, first-aid and medical facilities, seatbelts, and special devices and equipment for protecting personnel from specific hazards are covered in other sections of this manual. Such specified protective equipment will be furnished by the contractor and worn by employees when exposed to the respective hazards.

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Section 9

SIGNS, SIGNALS, AND BARRICADES

9.1 GENERAL

9.1.1 ***Requirement.*** This section establishes design specifications governing safety signs, tags, and barricades used on construction sites administered by the Bureau of Reclamation. Also, covered in this section are standard hoisting signals and provisions relating to the use of signalmen.

9.2 SIGNS

9.2.1 ***Application.*** Signs described in this subsection shall be visible at all times when work is in progress and shall be promptly removed or covered when the hazard no longer exists.

9.2.2 ***Standards.*** In addition to the design specifications set forth in this subsection, the design and application of signs shall be in conformance with the latest edition of the following standards:

a. ANSI Z35.1, "Specifications for Accident Prevention Signs"

b. OSHA-1910.145, "Specifications for Accident Prevention Signs and Tags"

c. ANSI D6.1, "Manual on Uniform Traffic Control Devices for Streets and Highways"

9.2.3 ***Danger signs.*** Danger signs shall conform to the following requirements:

a. Application. Danger signs shall be used only where there is imminent danger to the lives of employees or others.

b. Design, As illustrated in figure 9-1, danger signs shall have red as the predominating color for the upper panel, black outline on the borders, and a white lower panel for additional wording.

c. Sizes and specifications. Specifications, including sign sizes, applicable to danger signs are set forth in subparagraph 9.2.2.b.

9.2.4 ***Caution signs.*** Caution signs shall conform to the following requirements:

a. Application. Caution signs shall be used to warn against potential hazard and to caution employees against unsafe practices.

b. Design. As illustrated in figure 9-2, caution signs shall have yellow as the predominating color, black upper panel and borders, yellow lettering of "CAUTION" on the black panel, and the lower yellow panel for additional wording in black.

c. Sizes and specifications. Refer to subparagraph 9.2.2.b.

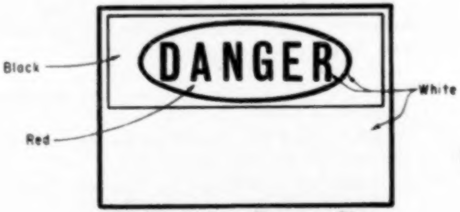

Figure 9-1. —Danger Sign

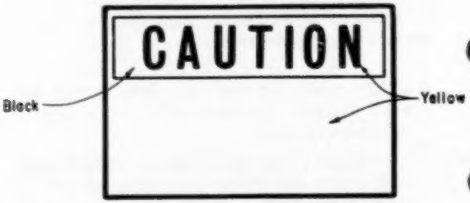

Figure 9-2. —Caution sign

9.2.5 **Exit and fire protection signs.** Fire exits, fire protection equipment, and physical hazards shall be identified in accordance with ANSI Z53.1, "Safety Color Code for Marking Physical Hazards," or NFPA No. 101 - "Life Safety Code."

9.2.6 ***Instructional safety signs.*** Signs intended for general safety instructions or information shall be designed with a green upper panel and white lower section. White letters on the green background shall convey the principal message. Additional information shall appear in black letters on the white background.

9.2.7 ***Directional signs.*** Directional signs, other than traffic signs specified in paragraph 9.2.8, shall be white with a black panel and a white directional symbol. Directional information, if used, shall appear in black letters on a white background.

9.2.8 ***Traffic signs and barricades.*** Traffic signs and barriers shall conform to the following requirements:

a. Design and use. Signs and barricades erected by the contractor on public highways or roads shall comply with the standards and regulations of the State or county highway department having jurisdiction. Traffic signs and barricades erected in construction areas under Bureau of Reclamation jurisdiction shall conform with the current ANSI D6.1, "Manual on Uniform Traffic Control Devices for Streets and Highways."

b. Installation and removal. Appropriate traffic control signs and devices shall be erected prior to use of the roadway or area, and promptly removed when no longer required.

c. Visibility. Signs and barricades shall be maintained clean and legible. Signs and barricades having any application at night shall be reflectorized or illuminated as appropriate. Signs and barricades shall be visible at all times and not obscured by parked equipment or other objects.

d. Traffic controls. When signs and barricades do not provide adequate protection, or when directed by the Contracting Officer's representative, the contractor shall provide flagmen or other appropriate traffic controls.

9.3 ACCIDENT PREVENTION TAGS

9.3.1 ***Application.*** Accident prevention tags are intended to warn employees and others of an existing hazard. They are intended for temporary use to warn of equipment under repair, defective tools or equipment, and lockout.

9.3.2 ***Design.*** Accident prevention tags shall conform to the current ANSI Z35.2, "Specifications for Accident Prevention Tags." Appendix E, Accident Prevention Tags, illustrates accident prevention tags applicable to construction operations.

9.4 RADIATION WARNING

9.4.1 ***Lasers.*** Laser warning signs and symbols shall conform with the design specifications in the current issue of ANSI Z35.1, "Specifications for Accident Prevention Signs."

9.4.2 ***Ionizing radiation.*** Ionizing radiation warning signs and symbols shall conform with the design specifications in the current issue of ANSI 35.1, "Radiation Symbol."

9.4.3 ***Radio frequencies.*** Signs warning of harmful radio frequencies shall display the standard warning symbol as described in the current issue of ANSI C95.2, "Radio Frequency Radiation Hazard Warning Symbol."

9.5 CRANE AND HOIST SIGNALS

9.5.1 ***Application.*** A uniform standard signal system shall be used in the operation of cranes, derricks, and hoists. Hand signals may be used when the distance between the operator and the signalman is not over 200 feet. Radio, telephone, or a visual and audible electrically operated system shall be used when the signalman cannot be clearly seen by the operator, or when the distance exceeds 200 feet.

9.5.2 ***Hand signals.*** When hand signals are used for the operation of cranes, derricks, and hoisting equipment, they shall conform to those illustrated in appendix F, Hand Signals for Cranes and Hoisting Equipment.

9.5.3 ***Posting.*** Signals shall be posted at the operator's position; and as practical, at signal control points, and such other locations necessary to inform those using the signals.

9.5.4 ***Signal systems.*** Signal systems shall be protected from unauthorized use, damage, or interference.

9.6 TRAFFIC CONTROL SIGNALS

9.6.1. ***Requirement.*** Flagmen directing traffic shall use the signals and procedures contained in the current issue of ANSI D6.1, "Manual on Uniform Traffic Control Devices for Streets and Highways." The control of mechanized construction equipment during backing operations is specifically set forth in paragraph 19.6.8.

9.7 SIGNALMEN AND FLAGMEN

9.7.1 ***Requirement.*** Only employees who are dependable, trained, qualified, and state certified, when applicable, shall be used as signalmen and flagmen. Flagmen controlling traffic shall wear high visibility fluorescent apparel as described in paragraph 8.6.2 Crane and hoist signals will be given by a predesignated signalman identified by special color of hardhat, armband, or other distinguishing marking.

Section 10

FIRE PREVENTION AND PROTECTION

10.1 GENERAL

This section sets forth requirements applicable to all construction activities under the administration of the Bureau of Reclamation. In addition to the requirements of this section, additional fire prevention and protection requirements relating to specific hazards and operations such as use of flammables and combustibles, asphalt and tar operations, welding and cutting, etc., are set forth in the appropriate sections of this manual.

10.2 FIRE PREVENTION

10.2.1 ***Housekeeping***. Good housekeeping, with provision for prompt removal and disposal of accumulations of combustible scrap and debris, shall be maintained in all areas of the jobsite. Self-closing metal containers shall be used for disposal of waste saturated with flammable liquids.

10.2.2 ***Codes and regulations***. The contractor shall comply with the requirements published in the current revisions of the National Electrical Code and the National Fire Protection Association standards.

10.2.3 ***Smoking***. Smoking or other sources of ignition shall not be permitted in areas where flammable or explosive materials are stored or are present. All such areas shall be conspicuously posted: **NO SMOKING OR OPEN FLAMES.**

10.2.4 ***Fires***. Fires and open flame devices shall not be left unattended unless protected with automatic temperature control and cutoff devices.

10.2.5 ***Cleaning and degreasing***. Gasoline and liquids with a flash point below 100 °F shall not be used for cleaning and degreasing.

10.2.6 ***Fireproofing.*** When space does not permit adequate clearance between heating facilities and combustible materials, an approved 1-hour fire resistive barrier shall be installed, providing a free flow of air between the barrier and flammable material.

10.2.7 ***Explosive gases or vapors.*** In areas where highly flammable or explosive gases or vapors may be present, necessary heat shall be provided through ductwork protected from the source of flame, or by steam or hot water heating systems.

10.2.8 ***Buildings and structures.*** Nonfire resistive buildings or structures shall be separated by a minimum distance of 25 feet. In a group of nonfire resistive buildings, aggregate ground floor areas which do not exceed 2,000 square feet shall be considered as one building for this purpose; providing each building in the group is horizontally separated by at least 10 feet on each side from other buildings.

10.2.9 ***Building exits.*** All buildings, shops, and plant facilities in which employees are required to work shall have at least two well-marked and lighted exits, permitting unobstructed escape in an emergency.

10.2.10 ***Inspections.*** When the size and/or nature of the operation justifies, or when directed by the Contracting Officer's representative, watchmen shall make frequent inspections of buildings, storage areas, employees' quarters, and work areas.

10.3 FIRE PROTECTION

10.3.1 ***Plan.*** The contractor shall prepare and carry out an effective fire protection and prevention program, including provision for the fire protection and suppression equipment set forth in this subsection.

When requested, the plan shall be submitted to the Contracting Officer's representative for approval.

10.3.2 *Fire extinguishers*

a. Requirement. Fire extinguishers, of appropriate type indicated in appendix G, Fire Extinguisher Data, shall be provided as specified or required. Fire extinguishers shall be suitably placed, distinctly marked, and readily accessible.

b. Maintenance. Fire extinguishers, protection systems, and alarms shall be inspected and maintained in accordance with appendix H, Inspection Schedule for Fire Protection Equipment.

c. Class A extinguishers. A fire extinguisher rated not less than 2A or equivalent shall be provided for each 3,000 square feet of the building area, or major fraction thereof. Travel distance from any point of the protected area to the nearest fire extinguisher shall not exceed 100 feet. One or more fire extinguishers rated not less than 2A, or equivalent, shall be provided on each floor of the building, with at least one located adjacent to each stairway.

d. Class B extinguishers. At least one extinguisher, having a rating of not less than 20B units, shall be located outside but not more than 10 feet from the door opening into any room used for storage of more than 60 gallons of flammable or combustible liquids. At least one extinguisher, having a rating of not less than 20B units, shall be located not less than 25 feet, nor more than 75 feet, from any flammable liquid storage area located out-of-doors.

e. Class B:C. A fire extinguisher, rated not less than 10 B:C, shall be provided within 50 feet of wherever more than 5 gallons of flammable or combustible liquids, or 5 pounds of flammable gas are being used. This requirement does not apply to the integral fuel tanks of motor vehicles or mechanized equipment. At least one extinguisher having a rating of not less than 20 B:C units shall be provided on all tank trucks and service trucks used for transporting and/or dispensing flammable or combustible liquids.

f. Carbon tetrachloride. Carbon tetrachloride and other toxic vaporizing liquid fire extinguishers are prohibited.

10.3.3 ***Contractor's plant.*** In addition to fire extinguishers, the concrete plant, screening plant, carpenter shop, major flammable material storage areas, and other construction facilities, when considered critical to the timely completion of the contract or constitute a hazard to employees or Government property, shall be protected with standpipes and at least a 1.5-inch fire hose capable of reaching all areas of the plant. The standpipe and hose shall be capable of discharging at least 25 gallons per minute for a period of 1 hour.

10.3.4 ***Major construction projects.*** When provided in the contract specifications, a trained firefighting organization, meeting NFPA (National Fire Protection Association) criteria, shall be provided by the contractor. Mobile and fixed firefighting equipment shall be provided and installed in accordance with NFPA recommendations. The contractor's plant shall be protected by standpipes and at least a 1.5-inch firehose with a minimum capacity of 25 gal/min for a period of 1 hour.

10.3.5 ***Restricted use.*** Firefighting equipment shall be operative at all times, and shall not be used for purposes other than extinguishing fires.

10.3.6 ***Sprinkler protection.*** When sprinkler systems are provided, they shall be designed and installed in accordance with NFPA 13, "Standard for the Installation of Sprinkler Systems."

10.3.7 ***Fire alarm devices.*** A reliable fire alarm system shall be installed by the contractor for the purpose of alerting employees exposed to fire danger, and alerting the local fire department in an emergency. These devices shall be installed as soon as practicable, with reporting and evacuation instructions conspicuously posted on the jobsite.

10.3.8 ***Offsite assistance.*** The following requirements shall be met in arranging for offsite assistance:

a. Written agreement. When the contractor relies on offsite assistance for fire protection, a written agreement covering the nature and type of assistance available should be secured, if possible. Otherwise, a letter shall be provided the Contracting Officer stating the nature of the assistance together with details covering the equipment and personnel to be made available.

b. Standpipe and hydrant connections. When offsite assistance is provided, standpipe and hydrant connections shall be compatible with the equipment available from the fire department providing the assistance.

c. Reporting. Emergency telephone numbers and reporting instructions shall be posted on the jobsite.

10.3.9 ***Water supply.*** A temporary or permanent water supply with volume and duration of flow and pressure sufficient to supply the standpipes, hose stations, and/or sprinkler systems shall be installed prior to, or concurrently with, the construction of the facility to be protected. In permanent structures under contract, in which standpipes are installed, they shall be connected to the water supply, if available, installed concurrent with the structure, and maintained in operable condition for fire protection use. The standpipes shall be provided with siamese fire department connections on the outside of the structure, conspicuously marked and located in an accessible location at street or road level.

10.4 BURNING AREAS

10.4.1 ***Approval.*** Where it is necessary to dispose of combustible waste by onsite burning, designated burning areas shall be established with approval of the Contracting Officer's representative. Establishment of burning areas and disposal methods shall be in compliance with Federal, State, and local regulations and guidelines. The contractor shall coordinate burning with the Government agencies responsible for monitoring fire danger in the area.

10.4.2 ***Controlled burning.*** Sufficient men and equipment shall be maintained at the designated burning site to properly control the operation and to prevent the spread of fire.

10.5 TEMPORARY HEATING DEVICES

10.5.1 ***General.*** The following requirements shall govern the use of temporary heating devices by the contractor:

a. Approval. Only temporary heating devices which have been approved by the Contracting Officer's representative shall be used. A reliable operating procedure shall be established in order to ensure:

(1) proper placement and servicing,
(2) safe clearance from combustible material,
(3) close surveillance and maintenance,
(4) safe fuel storage and refueling, and
(5) prompt detection of gaseous contamination or oxygen deficiency.

b. Data plates. Each heater shall have permanently affixed to it a data plate providing the following information:

(1) required clearances,
(2) ventilation requirement,
(3) fuel type and input pressure,
(4) lighting and extinguishing instructions, and
(5) electrical power supply characteristics.

c. Wood floors. Heaters not suitable for use on wood floors shall be so marked and shall not be set on combustible materials. When such heaters are used, they shall rest on suitable noncombustible material equivalent to at least 1 inch of concrete. The noncombustible material shall extend at least 2 feet beyond the heater in all directions.

d. Combustible covering. Heaters used in the vicinity of tarpaulins, canvas, or similar combustibles shall be located at least 10 feet from such combustibles. The coverings shall be securely fastened or tied down.

e. Stability. Heaters shall be set on level surfaces and located so as to minimize danger of upset.

f. Venting. Solid-fuel, gas, or liquid-fueled space heaters used in an enclosed building or structure shall be vented by a flue pipe to the outside. Properly insulated and ventilated sleeves or roof jacks shall be used when flues or smoke pipes pass through combustible material. (Refer to NFPA 211.)

g. Spark arresters. Spark arresters shall be installed on smoke stacks which could otherwise permit sparks to escape.

10.5.2 ***Liquid-fuel heaters.*** The following requirements shall govern the use of liquid-fuel heaters:

a. General. Liquid-fuel heaters may be either direct or indirect fired. Permissible fuels are kerosene, stove oil, fuel oil, coal oil, and diesel oil. The flashpoint of the fuel shall not be less than 100 °F.

b. Stability. Liquid-fuel heaters shall be either securely anchored or located so as to prevent upset.

c. Design. Liquid-fuel heaters shall be equipped with an automatic flame loss device which will prevent the flow of fuel when the flame is extinguished.

d. Fueling. Employees assigned to fueling shall be trained and thoroughly familiar with the manufacturer's instructions for operation and fueling of the heater. Prior to fueling, the heater shall be extinguished and permitted to cool to touch. Fuel shall be stored in and dispensed from covered approved-type flammable liquid containers.

e. Maintenance. Heaters shall be maintained in good operating condition. Provisions shall be made for periodic cleaning of oil reservoirs, jets, and other parts as specified by manufacturer.

f. Grounding. All noncurrent carrying metal parts of heaters shall be electrically bonded and grounded.

10.5.3 ***Natural gas heaters.*** The following requirements shall apply to the use of natural gas heaters:

a. General. Natural gas heaters shall be installed, operated, and maintained in accordance with the manufacturer's instructions.

b. Stability. Heaters shall be securely anchored to prevent upset or movement.

c. Piping. Piping, tubing, or hose shall be leak tested after installation, using a safe detection means such as soap suds. When flexible gas supply lines are used, they shall not exceed 25 feet in length. Supply lines and hose shall have a minimum working pressure of 250 lb/in^2(gage) and minimum burst pressure of 1250 lb/in^2(gage).

d. Connections. Hose, pipe, and tubing connections shall be threaded and capable of withstanding a gage test pressure of 125 lb/in^2 and a pull test of 400 pounds without leakage.

e. Fuel cutoff. Heaters shall be equipped with an automatic flame loss device which will shut off the gas supply if the flame or pilot is extinguished.

f. Grounding. All noncurrent carrying metal parts of fan-assisted heaters shall be electrically bonded and grounded.

10.5.4 ***Liquefied petroleum gas heaters.*** The following requirements shall govern the use of liquefied petroleum gas heaters:

a. General. Liquefied petroleum gas heaters shall be installed, operated, and maintained in accordance with the manufacturer's instructions.

b. Protection. Heaters, when in use, shall be protected from damage by location, anchoring, or barricading.

c. Testing. Piping, tubing, and hose connections shall be leak tested following installation, using a safe detection device such as soap suds.

d. Hoses. Only hose labeled **LP-Gas** or **LPG** shall be used. Hose shall have a minimum working gage pressure of 250 lb/in^2 and a minimum burst gage pressure of 1250 lb/in^2. If LP-gas is supplied to the heater by a hose supply line, the hose shall not be less than 10 feet in length nor more than 25 feet. Shorter hoses may be used with heaters as described in subparagraph 10.5.4.i.(2).

e. Hose connection. Hose, pipe, and tubing connections shall be threaded and capable of withstanding, without leakage, a gage test pressure of not less than 500 lb/in^2, and a pull test of 400 pounds.

f. Regulator. Heaters shall be equipped with an approved regulator in the supply line between the cylinder and the heater.

g. Check valve. Fuel cylinder connectors shall be provided with an excess flow check valve to minimize the flow of gas in the event the fuel line is ruptured.

h. Fuel cut-off. Heaters shall be equipped with an automatic flame-loss device which will shut off the gas supply if the flame or pilot is extinguished.

i. Fuel supply in buildings. Gas cylinders or containers shall be permitted in buildings or structures only in accordance with the following provisions:

(1) The maximum water capacity of individual cylinders shall not exceed 100 pounds nominal LP-gas capacity.

(2) For temporary heating such as curing concrete, drying materials, and similar uses, heaters (other than integral heater-container units) shall be located at least 6 feet away from any LP-gas container. This shall not prohibit the use of heaters specifically designed for attachment to the container or to a supporting structure with connecting hose less than 6 feet, provided the system is designed and installed to prevent direct applications of radiant heat from the heater onto the container. Blower-type or radiant heaters shall not be directed toward any LP-gas container within 20 feet.

(3) When two or more heaters are located in an unpartitioned area on the same floor, the LP-gas containers supplying the respective units shall be separated by at least 20 feet.

(4) LP-gas containers manifolded together supplying one or more heaters in an unpartitioned area on the same floor shall not exceed 300 pounds nominal LP-gas capacity. Such manifolds shall be separated by at least 20 feet.

(5) On floors on which heaters are not connected for use, containers are permitted to be manifolded together for connection to one or more heaters located on another floor provided that: (a) the total nominal capacity of containers connected to any one manifold shall not exceed 1,000 pounds LP-gas, and (b) where more than one manifold having a nominal capacity exceeding 300 pounds LP-gas is located in the

same unpartitioned area, the manifolds shall be separated by at least 50 feet.

j. Refilling containers. LP-gas containers shall not be refilled inside of buildings or structures. Refilling of containers shall be performed in accordance with paragraph 11.14.8.

k. Storage of containers. LP-gas containers not in use shall be stored outside, in accordance with the minimum distances set forth in paragraph 11.14.9.

l. Grounding. LP-gas systems, including containers, shall be grounded and bonded, and electric motors used in such systems shall be grounded and connected to a grounded electrical supply.

10.5.5 ***Restricted use.*** The following restrictions shall apply to the use of temporary devices:

a. Open flame-type heaters. Use of open flame-type heating devices having exposed fuel below the flame is prohibited.

b. Lubrication or service areas. Heating equipment of an approved type may be installed in lubrication or service areas where flammable liquids are not dispensed or transferred, provided the bottom of the heater is at least 18 inches above the floor and protected from damage. When flammable liquids are dispensed in such areas, the heater shall be of a type approved for garages, and installed at least 3 feet above the floor.

c. Tunnels and shafts. LP-gas heaters or natural gas shall not be permitted in tunnels, shafts, siphons, or similar locations.

Section 11
MATERIAL HANDLING, STORAGE, AND DISPOSAL

11.1 OPEN YARD STORAGE

11.1.1 ***Combustible materials.*** Combustible materials shall be stacked securely, and stacks or piles shall not exceed 16 feet in height. No combustible material shall be stored within 10 feet of a building or structure.

11.1.2 ***Access.*** Driveways between and around combustible storage piles shall be at least 15 feet wide and shall be maintained free from accumulations of material or rubbish. Driveways in open-yard, combustible-material storage areas shall be planned with a maximum grid system unit of 50 by 150 feet.

11.1.3 ***Powerlines.*** Pipe, conduit, steel, and other conductive materials shall not be stored under overhead powerlines. Nonconductive materials, such as lumber, poles, blocks, etc., may be stored under overhead powerlines provided the material-handling equipment cannot come within the minimum clearance distances set forth in paragraph 12.9.4.

11.1.4 ***Fire protection.*** Portable fire extinguishing equipment, suitable for the type of material and degree of hazard involved, shall be provided at accessible marked locations in the yard. Portable fire extinguishers, rated not less than 2A, shall be placed so that maximum travel distance to the nearest unit does not exceed 100 feet.

11.2 INDOOR STORAGE

11.2.1 *General.* Materials shall be stored in a planned and orderly manner, so as not to endanger the safety of employees. Stacks, tiers, and piles shall be stable and stacked to facilitate safe handling and loading.

11.2.2 *Access.* Materials shall not be placed or stored so as to interfere with accessways, doorways,

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or hoistways. Accumulations of scrap or materials shall not be permitted to obstruct accessways and exits. Aisle width shall be adequate to accommodate the fire fighting equipment.

11.2.3 ***Fire prevention.*** Materials shall be stored, handled, and piled with consideration for their fire characteristics. Noncompatible materials which may create a fire hazard shall be separated by a distance of at least 25 feet, or isolated by a barrier having at least a 1-hour fire rating. Material shall be piled to minimize the spread of fire internally and to permit convenient access for firefighting.

11.2.4 ***Fire doors.*** A clearance of 14 inches shall be maintained around the path of travel of fire doors unless a barricade is provided. Material or equipment shall not be stored within 36 inches of a fire door opening.

11.2.5 ***Sprinklers.*** Clearance of at least 36 inches shall be maintained between stored materials and sprinkler heads.

11.2.6 ***Fire protection.*** Fire protection shall be furnished in compliance with section 10 and as specified in other parts of this section.

11.2.7 **Floor loading.** Except for floors or slabs on grade, the maximum safe load limits in pounds per square foot shall be conspicuously posted in all indoor storage areas. These maximum safe loads shall not be exceeded.

11.2.8 ***Buildings under construction.*** Material stored inside buildings under construction shall not be placed within 6 feet of any hoistway or inside floor openings, nor within 10 feet of an exterior wall which does not extend above the top of the material stored.

11.3 BAGGED MATERIAL

11.3.1 ***Stacking.*** Bagged materials shall be stacked by stepping back the layers and cross-keying the bags at least every 10 bags high, except when restrained by walls or partitions of adequate strength.

11.4 BULK STORAGE

11.4.1 ***Lifelines.*** Employees entering silos, hoppers, tanks, bins, and similar bulk storage containers shall be equipped with attended lifelines and safety belts meeting the requirements of section 8. They shall also be protected by appropriate-type respiratory devices. (Refer to appendix C.)

11.4.2 ***Lockout.*** The drive motors of conveying equipment servicing bulk storage containers shall be tagged and locked out when employees are inside of the storage containers.

11.5 LUMBER

11.5.1 ***Stability.*** Lumber shall be stacked on level and solidly supported sills in a manner that the stacks are stable and self-supporting.

11.5.2 ***Height.*** Lumber piles shall not exceed 16 feet in height.

11.6 BRICK AND MASONRY BLOCKS

11.6.1 ***Stability.*** Brick and masonry blocks shall be stacked on level and solid surfaces.

11.6.2 ***Brick.*** Brick stacks shall not exceed 7 feet in height. When a loose brick stack reaches a height of 4 feet, it shall be stepped back at least 2 inches in every foot of height above the 4-foot level. Unitized brick shall not be stacked more than three units in height.

11.6.3 ***Masonry blocks.*** Masonry blocks stacked higher than 6 feet shall be stepped back one-half block per tier above the 6-foot level.

11.7 CEMENT AND LIME

11.7.1 ***Bulk cement and lime.*** Workmen handling bulk cement or lime shall wear protective gloves, clothing, respirators, and goggles. They shall be provided with washing facilities, handcream, petroleum jelly, or similar preparations for protection from dermatitis.

11.7.2 ***Stacking.*** Unless laterally supported, sacked cement and lime shall not be stacked over 10 bags high without stepping back the layers and cross-keying the bags. Bags shall be removed uniformly from the top of the stacks to avoid tipping of the stacks.

11.7.3 ***Lime.*** Unslaked lime shall be stored in a dry area, and due to fire hazard, shall be separated from other materials.

11.8 REINFORCING, SHEET, AND STRUCTURAL STEEL

11.8.1 ***Stacking.*** Steel shall be safely stacked to prevent sliding, rolling, spreading, or falling.

11.8.2 ***Lagging.*** When steel is handled by a crane or forklift, lagging shall be used to facilitate safe rigging.

11.8.3 **Taglines.** When a crane is used to handle reinforcing or structural steel, taglines shall be used to control the load.

11.9 PIPE, CONDUIT, AND CYLINDRICAL MATERIAL

11.9.1 ***Stacking.*** Pipe, conduit, bar stock, and other cylindrical materials, unless placed in racks, shall be stacked on a firm, level surface and shall be blocked to prevent spreading, rolling, or falling; either a pyramided or battened stack shall be used. Battened stacks shall be stepped back at least one unit per tier and securely chocked on both sides of the stack.

11.9.2 ***Removal.*** Removal of pipe or conduit from a stack shall be done from the ends of the pipe or conduit.

11.9.3 ***Unloading.*** Unloading from a carrier shall be done in such a manner that no person shall be exposed to the unsecured load.

11.9.4 ***Protection of public.*** In areas accessible to the public, the contractor shall use chocks or other equivalent method to prevent pipe or conduit sections from rolling.

11.10 WOOD POLES AND PILING

11.10.1 ***Stacking.*** Wood poles and round piling shall be stacked and handled in the manner specified in subsection 11.9.

11.10.2 ***Taglines.*** Taglines shall be used when lifting poles or piling.

11.11 SAND, GRAVEL, AND CRUSHED STONE

11.11.1 ***Stockpiles.*** Stockpiles shall be located so as to provide safe access for withdrawing material. Overhanging of material or vertical faces shall not be permitted.

11.11.2 ***Bins and partitions.*** Material stored agains[illegible] walls or partitions shall not be stored in an amount which will endanger the stability of the wall or partition.

11.12 FLAMMABLE AND COMBUSTIBLE LIQUIDS

11.12.1 ***General.*** For the purposes of this subsection, flammable and combustible liquids are classified as follows:

a. Flammable liquids (Class I liquids):

- Class I - Liquids having a flash point below 100 °F (38 °C)
- Class IA - Flashpoint below 73 °F (23 °C) and boiling point below 100 °F (38 °C)
- Class IB - Flashpoint below 73 °F (23 °C) and boiling point at or above 100 °F (38 °C)
- Class IC - Flashpoint at or above 73 °F (23 °C) but below 100 °F (38 °C)

b. Combustible liquids (Class II and III liquids):

- Class II - Liquids having a flashpoint at or above 100 °F (38 °C) and below 140 °F (60 °C)
- Class III - Flashpoint at or above 140 °F (60 °C)

11.12.2 ***Common flammable and combustible liquids.*** Appendix I, Common Flammable and Combustible Liquids, lists the classification an[illegible] pertinent characteristics of commonly used flammable and combustible liquids.

11.12.3 ***Class IA flammable liquids***

a. Restricted use. Due to the extreme explosio[illegible] hazard of class IA liquids, they shall not be purchased until storage, dispensing, and use procedures have been approved by the Contracting

Officer. The contractor shall submit a letter to the Contracting Officer's representative stating the name and description of the liquid, its characteristics, and a detailed description of its intended use, together with the health and safety precautions he intends to follow. This requirement shall not apply to small quantities of starter fluid.

b. Substitute product. Wherever practical, a less hazardous product shall be used.

c. Controlled use. Storage, dispensing, and use of Class 1A liquids, including design of the storage and dispensing system, shall be determined by and under supervision of an engineer or scientist competent in the field.

11.12.4 ***Toxicity of flammable and combustible liquids.*** Most flammable and combustible liquids are highly toxic and should not be used until their toxic characteristics have been determined. The appropriate health and safety requirements set forth in section 7 shall be followed in handling toxic liquids.

Table 11-1.—*Maximum container storage capacities of flammable liquids*

Container	*Maximum amount*
Glass	1 quart[1]
Metal or approved plastic	5 gallons
Approved safety containers	5 gallons
Metal drums (DOT Spec.)	60 gallons
Approved portable tanks	660 gallons

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[1] Up to 1 gallon of Class IC and II, and 5 gallons of Class III liquids may be stored in glass containers.

11.12.5 ***Storage containers.*** Only containers and portable tanks of the type shown in Table 11-1 and meeting DOT and/or NFPA design standards shall be used to store flammable and combustible liquids (Class IA excluded), and in amounts specified.

11.12.6 ***Indoor storage.*** (Class IB, IC, II, and III)

Table 11-2—*Maximum container storage of flammable and combustible liquids*

Fire protection installed[1]	*Fire rating*	*Maximum size*	*Maximum quantity gal/ft²*
Yes	2 hours	500 ft²	10
No	2 hours	500 ft²	4
Yes	1 hour	150 ft²	5
No	1 hour	150 ft²	2

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[1] Fire protection systems shall be either sprinkler, water spray, carbon dioxide, or equivalent system approved by a nationally recognized testing laboratory.

a. Limitation. Not more than 25 gallons of flammable or combustible liquids shall be stored in a room or single fire area unless they are in an approved storage cabinet or flammable liquid storage room. Garages and automotive repair shops, separated from other buildings or isolated by a 1-hour fire wall, are exempt from this requirement provided storage is limited to Class II and III liquids in approved-type drums, tanks, or containers, as specified in paragraph 11.12.5.

b. In storage cabinets. Not more than 60 gallons of Class I and II liquids, nor more than 120 gallons of Class III liquids may be stored in an approved-type storage cabinet. Not more than three such cabinets may be located in a single room or fire area unless separated by at least 100 feet.

c. In storage rooms. Amounts of flammable or combustible liquids (Class IA excluded) indicated in Table 11-2 may be stored in approved-type inside storage rooms.

11.12.7 *Approved storage cabinets*

a. Design. Storage cabinets for flammable and combustible liquids shall conform to the design and construction standards set forth in NFPA 30, "Flammable and Combustible Liquids Code."

b. Wooden cabinets. Wooden storage cabinets constructed to the following specifications are permissible: All lumber used shall be exterior grade plywood with a minimum nominal thickness of 1 inch. All joints shall be rabbeted and fastened in two directions with flathead wood screws. Doors shall be hinge mounted, tight fitting, and when more than one door is used, there shall be a rabbeted overlap of at least 1 inch. The cabinets shall be painted inside and out with at least two coats of fire retardant paint.

c. Posting. All cabinets shall be conspicuously labeled - **FLAMMABLE - KEEP FIRE AWAY.**

d. Fire protection. At least one fire extinguisher rated not less than 20-B units shall be located not less than 10 nor more than 25 feet from each cabinet.

11.12.8 *Approved inside storage rooms*

a. Design. Inside storage rooms shall be designed and constructed to meet the fire rating specified in table 11-2. Inside storage rooms shall meet the standards set forth in NFPA 30, "Flammable and Combustible Liquid Code."

b. Fire protection. Automatic extinguishing systems installed in storage rooms shall be approved by a nationally recognized testing laboratory. Storage rooms not protected by automatic extinguishing systems shall be protected as set forth in subparagraph 10.3.2.d.

c. Ventilation. Inside storage rooms shall be vented with either a gravity or mechanical exhaust system located not more than 12 inches above the floor. The system shall provide a minimum of six changes of air per hour. Mechanical exhaust systems shall be controlled by a switch located outside of the room. The same switch shall control the lights in the storage room, and if flammable liquids are dispensed within the room, an indicator light shall be installed adjacent to the switch. When gravity systems are used, both the fresh air intake and the exhaust outlet shall be on the exterior of the building.

d. Electrical. Electrical wiring and equipment shall be approved for Class I, Division I, Hazardous Location, per the National Electrical Code.

e. Aisles and stacking containers. In storage rooms, a clear aisle at least 3 feet wide shall be maintained. Containers exceeding 30 gallons capacity shall not be stacked.

11.12.9 *Outside storage*

a. Containers. Flammable and combustible liquids may be stored outside in approved containers not exceeding 60 gallons capacity, subject to the following requirements:

(1) Any one group of containers stored together shall not exceed 1,100 gallons. Each group of containers shall be separated at least 5 feet and no group shall be within 25 feet for a building or other combustibles.

(2) The storage area shall be diked at least 12 inches high or graded to divert spillage away from building or other hazardous exposure.

(3) Each group of containers shall be located adjacent to an accessway at least 12 feet wide to facilitate the use of firefighting equipment.

b. Portable tanks (aboveground). Approved-type portable tanks not exceeding 660 gallons capacity may be used for outside aboveground storage of flammable or combustible liquids providing:

(1) When two or more tanks are grouped, having a combined capacity over 2,200 gallons, they shall be separated by a 5-foot clear area.

(2) Portable tanks shall not be located within 25 feet of a building or combustible material.

(3) The area shall be kept free of weeds and combustible materials and either diked or sloped to permit safe containment of leaks or spills.

(4) Portable storage tanks shall be equipped with emergency venting and other devices as required in NFPA 30.

(5) Each tank shall be located adjacent to an accessway at least 12 feet wide to facilitate use of firefighting equipment.

c. Fire protection. At least one portable fire extinguisher rated not less than 20-B units shall be located not less than 25 feet nor more than 75 feet from each portable tank or group of containers located outside.

11.12.10 ***Handling and dispensing flammable or combustible liquids***

a. Dispensing area. Areas in which flammable or combustible liquids are transferred in quantities greater than 5 gallons at a time shall be separated from other operations by at least 25 feet, or by a partition having a minimum 1-hour fire rating. Drainage or an equally effective method shall be used to contain spills.

b. Ventilation. Adequate natural or mechanical ventilation shall be provided in order to maintain the concentrations of flammable vapor at less than 10 percent of the lower flammable limit.

c. Grounding. The transfer of flammable liquids (Class I) from one container to another shall require bonding of the containers and the transfer system. All dispensing systems shall be electrically grounded and bonded.

d. Dispensing. Flammable and combustible liquids shall be drawn from or transferred into vessels, containers, or tanks, only through a closed piping system, from safety cans, by means of a device drawing through the top, or from containers or tanks by gravity or pump, through a self-closing valve. Transferring by injecting pressurized air into a tank or container is prohibited.

e. Lighting and electrical equipment. Electrical lighting shall be the only means used to provide artificial illumination in areas where flammable liquids (Class I) are handled or dispensed, or where flammable vapor may be present. The wiring and all electrical equipment shall meet the requirements of NFPA designation: Class I, Division 2 of the National Electrical Code.

f. Covered containers. Class I and II liquids shall be kept in covered containers when not in use.

g. Flame and ignition. Open flame smoking or other sources of ignition shall not be permitted within a distance of 50 feet from areas where Class I flammable liquids are dispensed or used. Greater distance may be necessary under some conditions. Approved **No Smoking** signs shall be posted in such areas.

h. Leakage or spillage. Leakage or spillage of flammable or combustible liquids shall be promptly cleaned up and disposed of safely.

i. Refuse containers. Self-closing metal refuse containers shall be available in all areas where flammable or combustible liquids are dispensed or used.

11.12.11 ***Refueling***

a. Equipment. Tanks and equipment used for refueling vehicles and equipment, fueled with flammable or combustible liquids, shall be designed and installed in accordance with the applicable provisions of the NFPA Standards, Underwriters Laboratories, Inc., or Factory Mutual Standards, or have the approval of the Government agency having jurisdiction.

b. Tank trucks. Tank trucks shall comply with the requirements published in NFPA 385, "Standard for Tank Vehicles for Flammable and Combustible Liquids."

c. Dispensing hose. Hoses used to dispense flammable and combustible liquids shall be an approved type with an automatic self-closing valve or nozzle without a latch-open device.

d. Electrical equipment. Electrical wiring, pumps, and equipment shall meet the appropriate requirements of NFPA designation: Class 1 of the National Electrical Code. Clearly identified and accessible switch(es) shall be provided at a location remote from dispensing devices to shut off all power to such devices in an emergency.

e. Refueling equipment. Vehicles or equipment using gasoline, LP-gas or other flammable or combustible liquid fuels shall be shut down during refueling. Diesel equipment is excepted when fueled in accordance with manufacturer's recommendations.

f. Smoking. Approved **No Smoking** signs shall be posted on all mobile refueling equipment and in established refueling areas.

g. Fire protection. Refueling trucks, lube trucks, and established refueling areas shall have at least one fire extinguisher, rated not less than 20-B:C, located within 75 feet of fueling and/or servicing operations.

11.13 ASPHALT AND TAR PRODUCTS

11.13.1 ***Requirement.*** Employees handling or working with these materials shall be instructed in the necessary precautions and in the safe manner to handle such materials. The manufacturer's recommendations shall be made available and followed in the storage, handling, and application of these materials.

11.13.2 ***Protective clothing and equipment.*** Protective clothing, respiratory protection, and skin protection as specified in section 8 shall be used by employees handling or applying these materials.

11.13.3 ***Ventilation.*** In enclosed or confined areas in which hot tar, asphalt, enamel, or similar materials are being heated or applied, an approved method of mechanical ventilation shall be provided in accordance with paragraph 7.10.4. Testing and verification shall be in accordance with paragraphs 7.10.5 and 7.10.6.

11.13.4 ***Heating kettles.*** Asphalt or tar kettles, when in use, shall not be left unattended, and shall be placed on a firm, level base and protected against overturning. Kettles shall have an effective lid or hood, and a thermometer. Kettles shall not be used underground, in conduits, in or on enclosed buildings or structures.

11.13.5 ***Fire protection.*** A fire extinguisher, rated not less than 10B:C, shall be available at locations where heating devices or melting kettles are in use.

11.13.6 ***Handling.*** Adequate runways or accessways, clear of obstructions, shall be provided for employees carrying hot materials. Hot materials shall not be carried up or down ladders. Adequate hoisting devices shall be provided.

11.13.7 ***Thinners.*** Gasoline or similar volatile liquids shall not be used as thinners.

11.13.8 ***Hand spraying.*** Nozzlemen applying hot tar asphalt shall not be permitted to work under hoses supplying the material to the spray nozzle. Flexible metallic hoses fitted with insulated handles shall be used in hand spraying operations.

11.13.9 ***Housekeeping.*** Distributors, retorts, hoses, and related equipment shall be kept reasonably free of accumulations of asphalt and tar.

11.14 LIQUEFIED PETROLEUM GAS

11.14.1 ***Requirement.*** Storage, handling, installation, and use of liquefied petroleum gases and systems shall be in accordance with NFPA 58 and 29 CFR 1926.153-OSHA. Cylinders shall meet DOT specifications published in 49 CFR, Part 178, "Shipping Container Specifications."

11.14.2 ***Hazardous locations.*** Liquefied petroleum gas containers and equipment shall not be used in unventilated spaces, below grade in pits or trenches, below deck, or other areas where dangerous concentrations of gas may accumulate.

11.14.3 ***Tubing.*** Only tubing or piping approved for use in LP-gas systems shall be used. Aluminum or polyvinyl piping or tubing shall not be used.

11.14.4 ***Hose.*** Only hose labeled "LP-gas" or "LPG" shall be used. Hose shall have a minimum working gage pressure of 250 lb/in^2.

11.14.5 ***Valves and accessories.*** Valves, fittings, and accessories connected directly to the container, including primary shutoff valves, shall have a minimum working gage pressure of 250 lb/in^2 and shall be designed for LP-gas service.

11.14.6 ***Shutoff valves.*** Connections to containers, except safety relief connections, liquid level gaging devices, and plugged openings, shall have a shutoff valve located as close to the container as possible. Shutoff valves shall not be installed between the safety relief device and the container or the equipment or piping to which the safety relief device is connected, except where the arrangement and design of the shutoff valve is such that full required capacity flow through the safety relief device is always afforded.

11.14.7 ***Safety relief valves.*** Each container and vaporizer shall be equipped with one or more approved safety relief valves. These valves shall be installed to afford free vent to the outer air with the discharge not less than 5 feet horizontally away from any opening of the building which is below such discharge. Container safety relief devices and regulator relief vents shall be located not less than 5 feet from air openings into sealed combustion system appliances or mechanical ventilation air intakes.

11.14.8 ***Dispensing***

a. Portable containers. Filling of portable containers or containers mounted on skids, from storage containers, shall be performed outside not less than 50 feet from the nearest building.

b. Trucks or motor vehicles. Filling of fuel containers on trucks or motor vehicles from bulk storage containers shall be performed not less than 10 feet from a masonry-walled building, and not less than 25 feet from any other building or structure.

c. Refueling. Equipment using LP-gas shall be shut down during refueling operations.

11.14.9 ***Storage of cylinders and containers.*** Storage of LP-gas containers and cylinders not in use shall be outside of buildings or structures, at not less than the following distances from the nearest building or combustible material storage:

Quantity of LP-gas	Min. distance
500 lb or less	0 feet
501 to 6,000 lb	10 feet
6,001 to 10,000 lb	20 feet
Over 10,000 lb	25 feet

11.14.10 ***Fire protection.*** Storage locations shall be provided with at least one accessible portable fire extinguisher rated not less than 20-B:C, located not less than 25 feet nor more than 75 feet from the container.

11.14.11 ***Temporary LP-gas heaters.*** In addition to requirements in this subsection, temporary LP-gas heaters and equipment shall comply with paragraph 10.5.4.

11.15 PAINTS, VARNISHES, AND THINNERS

11.15.1 ***Storage.*** Paints, varnishes, lacquers, thinners, and other volatile paints or coatings shall be stored and dispensed in accordance with their flammability characteristics. Refer to subsection 11.12, Flammable and Combustible Liquids. Containers shall be tightly closed when not in use and not more than a 1-day supply shall be stored in buildings under construction.

11.15.2 ***Ventilation.*** Ventilation adequate to prevent the accumulation of flammable vapors in hazardous concentrations shall be provided in areas where paints and coatings are dispensed or applied. (Refer to subsection 7.10.)

11.15.3 ***Spray painting.*** No smoking, open flame, exposed heating elements, or other sources of ignition shall be permitted in areas where flammable or combustible paints or coatings are being sprayed. Spray painting booths and equipment shall be in accordance with NFPA No. 33, "Standard for Spray Application Using Flammable and Combustible Materials."

11.15.4 ***Personal protective equipment.*** Employees exposed to paints or coatings potentially hazardous to their health shall be provided with, and use, appropriate protective equipment as set forth in section 8.

11.15.5 ***Electrostatic paint spraying***

a. Electrical. Transformers, power packs, control apparatus, and other electrical portions of the equipment, with exception of the gun and its connection to the power supply, shall be located outside of the spraying area.

b. Grounding. The handle of the spray gun shall be effectively grounded by a conductive device to ensure the gun and the operator are at the same ground potential.

11.16 HOUSEKEEPING

11.16.1 ***General.*** Work areas and storage areas shall be kept free of accumulations of scrap material. Stairways, accessways, and scaffolds shall not be permitted to become obstructed by accumulation of scrap, supplies, materials, or equipment. Combustible materials including weeds and grass shall be disposed of before becoming a fire hazard.

11.16.2 ***Lumber.*** Scrap lumber shall be placed in piles or containers and not be permitted to accumulate in work areas. Protruding nails shall be removed or bent over unless the scrap lumber is placed directly in containers for removal.

11.16.3 ***Flammable or combustible liquids.*** Spills of flammable or combustible liquids shall be promptly removed and safely disposed. Self-closing metal containers shall be provided for disposal of rags and waste soiled by flammable or combustible liquids.

11.16.4 ***Hazardous materials.*** Waste materials hazardous to humans or animals shall be disposed of as required by the Government agency having jurisdiction.

11.16.5 ***Burning.*** Requirements governing the burning of waste or scrap are set forth in subsection 10.4.

11.16.6 ***Tools and equipment.*** Tools and portable equipment shall not be strewn about in a manner which may cause tripping or injury. Where a falling hazard exists, tools, materials, and equipment shall be adequately secured.

11.16.7 ***Wind.*** Loose or light materials shall not be stored or left on roofs or unenclosed heights unless safely tied down or secured.

11.16.8 ***Sacks and bags.*** Empty bags having contained cement, lime, and other dust-producing material shall be removed from work areas at least daily.

11.16.9 ***Working aloft.*** Containers shall be provided for storing or carrying rivets, bolts, drift pins, and similar items when used aloft.

11.16.10 ***Excavated materials.*** Roads and walkways shall be kept clear of excavated materials wherever possible. Where this is not possible, they shall be adequately posted and/or barricaded, and other access provided.

11.16.11 ***Dropping material.*** Waste material and debris shall not be dropped or thrown a vertical distance exceeding 6 feet unless:

a. The area into which the material is dropped shall be completely enclosed with barricades not less than 6 feet back from the projected edge of the opening or level above. Signs warning of the hazard shall be posted at each level.

b. Safely designed chutes are installed providing protection for persons below. Chutes for debris and scrap shall be fully enclosed for their entire run except openings for insertion of materials. Such openings shall be equipped with covers or enclosures.

Section 12
ELECTRIC WIRING AND APPARATUS

12.1 GENERAL

12.1.1 ***Code requirement.*** Electrical installations, temporary or permanent, shall comply with the applicable provisions of the National Electrical Safety Code, National Electrical Code, and applicable State codes, unless otherwise provided by regulations of this section.

12.1.2 ***Approval required.*** Electrical wire, conduit, apparatus, and equipment shall be approved or listed by the Underwriters Laboratories, Inc., or Factory Mutual Laboratories, for the specific application.

12.1.3 ***Protection of employees***

a. Proximity. The contractor shall not permit an employee to work in such proximity to an electric circuit that he may contact it in the course of his work, unless the employee is protected against electric shock by deenergizing the circuit and grounding it, or by guarding it by effective insulation or other means.

b. Underground lines. In areas where employees may accidently contact underground lines, the lines shall be deenergized.

c. Prior to work. Prior to starting work in an area, a contractor supervisor shall ascertain by inquiry, direct observation, or by instruments whether any part of an electric power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool, or machine into physical contact with the circuit. Whenever possible, the circuit(s) shall be deenergized and grounded. Otherwise, the contractor shall protect the employees by isolation, insulation, warning signs, or other method commensurate with the hazard. He shall advise the employees of the location of such lines, the hazard, and protective measures to be taken.

12.1.4 ***Work qualification.*** Work on electrical circuits and equipment shall be performed only by personnel familiar with the code requirements and qualified to perform the type of work to which he is assigned.

12.1.5 ***Protective equipment.*** When it is necessary to work on energized lines and equipment which is at 440 volts or greater, approval will be obtained from the Contracting Officer's authorized representative. Also, rubber gloves and other approved protective equipment or hot-line tools meeting the provision of ANSI J-6 series shall be used.

12.1.6 ***Passageways.*** Effective barriers or other means shall be provided to ensure that areas containing electrical circuits or equipment will not be used as passageways when energized lines or equipment are exposed.

12.1.7 ***Live parts.*** Live parts of wiring or equipment shall be effectively guarded to protect persons or objects from harmful contact.

12.1.8 ***High-voltage equipment.*** Transformer banks, open breakers, and similar exposed high-voltage equipment shall be isolated to prevent unauthorized access. Effective isolation shall consist of locked rooms; fence or screen enclosures, walls, or partitions; or elevated locations. Entrances to these isolated areas shall be kept locked when not under constant observation. **DANGER-HIGH VOLTAGE** warning signs, shall be posted at entrances to these areas. Metallic enclosures shall be effectively grounded.

12.1.9 ***Work areas.*** High-voltage electrical wiring passing through work areas shall be covered, barricaded, or elevated to protect it from contact by vehicular or foot traffic.

12.1.10 ***Marking and posting.*** Powerlines, switches, breakers, metal cabinets, and protective enclosures, which are rated at 220 volts or greater, shall be plainly marked to indicate maximum operating voltages.

12.2 TEMPORARY WIRING

12.2.1 ***Installation.*** Temporary wiring shall be guarded, buried, or isolated by elevation to prevent accidental contact by personnel or equipment. Vertical clearance above walkways shall not be less than 10 feet for circuits rated 600 volts or less. All temporary wiring shall be supported on insulators.

12.2.2 ***Weatherproof.*** Conductors used in tunnels, shafts, trenches, and wet or damp locations shall be of a type approved for the purpose as listed in Article 310 of the National Electrical Code.

12.2.3 ***Bushings.*** Wiring installed in conduit shall be equipped with bushings at outlets and terminals.

12.2.4 ***Lighting strings.*** Temporary lighting strings shall consist of nonconductive lamp sockets and connections permanently molded to the conductor insulation. Bulbs attached to festoon lighting strings and extension cords shall be protected by lamp guards, unless deeply recessed in a reflector. Broken or defective bulbs shall be promptly replaced.

12.2.5 ***Extension cords.*** Extension cords shall be 3-wire grounded type listed by the Underwriters Laboratories, Inc.; the rated load shall not be exceeded.

12.3 DISCONNECT AND OVERCURRENT PROTECTION

12.3.1 ***Marking.*** Switches, fuses, and automatic circuit breakers shall be plainly marked, labeled, or arranged to permit identification of circuits or equipment controlled by them.

12.3.2 ***Switches.*** Switches shall be of the enclosed safety type, with the enclosures grounded, and installed so as to minimize the possibility of accidental operation.

12.3.3 ***Lockout provision.*** Switches and breakers, rated 440 volts or greater, shall be provided with a means of locking in the OFF position. Also, fuse cabinets and circuit breaker cabinets shall be equipped with lock-type doors.

12.3.4 ***Wet locations.*** Switches, circuit breakers, fuse panels, and motor controllers in wet or outside locations shall be enclosed in approved-type weatherproof cabinets or enclosures.

12.3.5 ***Shielding.*** Disconnecting means shall be either isolated or shielded to protect employees.

12.3.6 ***Incoming service.*** A readily accessible, manually operated switch shall be provided for each incoming service or supply circuit rated less than 5 kV.

12.3.7 ***Overcurrent protection.*** Overcurrent protection shall be provided by fuses or circuit breakers for each feeder and branch circuit. Such protection shall adequately protect the circuit, considering the current-carrying capacity of the conductors and the load demanded. No overcurrent device shall be placed in any permanently grounded conductor, except where the overcurrent device simultaneously opens all conductors of the circuit for running motor protection.

12.4 GROUND FAULT PROTECTION

12.4.1 ***Requirement.*** All 115- and 120-volt, single phase, 15- and 20-ampere receptacle outlets used for construction operations, shall be protected by a ground-fault circuit interrupter program or an equipment grounding conductor program to protect employees. The ground-fault circuit interrupter and grounding programs shall meet the requirements of this subsection.

12.4.2 ***Ground-fault circuit interrupter program.*** All 115- and 120-volt, single-phase, 15- and 20-ampere receptacle outlets shall be protected by a UL-listed ground-fault circuit interrupter installed in receptacles or distribution panels located near the worksite. The ground-fault interrupter shall open the circuit on a ground current of 6 milliamperes or greater and shall be equipped with an integral pushbutton test circuit. Such systems shall be installed in strict compliance with the manufacturer's specifications and shall be tested prior to use. Receptacles on a two-wire, single-phase, portable or vehicle-mounted generator rated 5 kW or less, where the circuit is insulated from the generator frame and other grounded parts, are excluded from this requirement.

12.4.3 ***Equipment grounding conductor program***

a. Requirement. The requirements set forth in this paragraph are in addition to other requirements for equipment grounding conductors. The program shall apply to all cord sets, receptacles, and equipment connected by cord and plug which are available for use by employees.

b. Written program. A written description of the program, including type of electrical equipment and wiring and safety precautions, shall be submitted to the Contracting Officer's representative for approval prior to installation.

c. Qualified person. The contractor shall designate one or more qualified persons familiar with the code requirements to supervise the implementation of the program.

d. Daily inspection. Each cord set, attachment cap, plug, and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects such as deformed or missing pins or insulation damage, and for indication of possible internal damage. Equipment found to be defective or damaged shall be removed from service and not used until repaired.

e. Tests. The following tests shall be made on all cord sets, receptacles which are used for construction operations, and cord and plug connected equipment required to be grounded.

(1) All equipment grounding conductors and receptacle outlets shall be tested for continuity and shall be electrically continuous.

(2) Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor and to ensure that the grounding conductor is connected to its proper terminal.

f. Test interval. The tests specified in subparagraph e shall be performed (1) before first use; (2) before equipment is returned to service following any repairs; (3) before equipment is used following an accident which could have damaged the grounding system; and (4) at intervals not to exceed 3 months, except that the interval may be 6 months for cord sets and receptacles which are fixed and not exposed to damage.

g. Test records. Unless a color coding system is implemented, the contractor shall maintain a written record of tests and inspections.

12.5 GROUNDING AND BONDING

12.5.1 ***Requirement.*** All wiring, electrical circuits, and equipment, except portable tools and appliances protected by a UL-approved system of double insulation, shall be effectively grounded in accordance with the latest edition of the National Electrical Code (NFPA 70), Article 250-Grounding.

12.5.2 ***Portable and plug connected equipment.*** The noncurrent carrying metal parts of portable and/or plug connected equipment not protected by a UL approved system of double insulation shall be grounded. Grounding shall be by a multiconductor cord having an identified grounding conductor and a multicontact polarized plug-in receptacle.

12.5.3 ***Fixed equipment.*** Exposed, noncurrent carrying metal parts of fixed electrical equipment, including motor, generators, frames and tracks of electrically operated cranes, electrically driven machinery, lighting standards, etc., shall be effectively grounded.

12.5.4 ***Effective grounds.*** The path from circuits, equipment, structures, and conduit or enclosures to ground shall be permanent and continuous, have ample carrying capacity for the current likely to be imposed on it, and have a resistance sufficiently low to permit sufficient current flow to operate circuit breakers and similar overcurrent devices in the circuit.

12.5.5 *Ground resistance.* Driven ground rod electrodes, where possible, shall have a resistance to ground not exceeding 25 ohms. When it is not possible to obtain a resistance of 25 ohms or less, two or more electrodes connected in parallel shall be used to obtain a resistance of 25 ohms or less.

12.5.6 *Testing grounds.* Following installation, grounded circuits shall be checked for continuity and to determine whether or not the overcurrent protective devices operate properly.

12.5.7 *Bonding.* Conductors used for bonding and grounding circuits and equipment shall be of sufficient size to safely carry the anticipated current. When attaching bonding and grounding clamps or clips, a secure and positive metal to metal contact shall be made. The ground end shall be attached first and the other end attached by using insulated tools or other suitable and safe devices. When removing grounds, the grounding device shall be removed first from the conductor or equipment using insulated tools or other suitable and safe devices. Such bonding and grounding attachments shall be made immediately after the circuit has been deenergized and before any work is started. Grounds shall not be removed until all work has been completed.

12.6 HAZARDOUS LOCATION

12.6.1 *Requirement.* Electrical wiring and equipment installed in **hazardous locations**, as defined in the National Electrical Code, shall conform to the respective standards set forth in the code. Further, all components and equipment used in hazardous locations shall be from among the equipment listed by a nationally recognized testing laboratory, such as Underwriters Laboratories, Inc. and Factory Mutual Engineering Corporation. Custom-made components and equipment certified by a registered electrical engineer proficient in the field are exempt from this requirement.

12.6.2 ***Installation.*** Equipment approved or listed for a specific hazardous location shall not be installed or intermixed with equipment approved for another hazardous location.

12.6.3 ***Maintenance.*** Wiring components and equipment shall be maintained as explosion proof as contemplated in their respective approvals.

12.7 WET LOCATIONS

12.7.1 ***Requirement.*** Only the following type electrical systems are permissible for use in wet areas where there is danger of electrical shock:

a. Ground-fault interrupter. Electrical circuits for lighting and handtools shall not exceed 120 volts and shall be protected by UL-listed ground-fault interrupters installed in conformance with the manufacturer's specifications.

b. Stationary portable electrical equipment. Stationary portable electrically powered equipment, such as pumps, heaters, blowers, welders, transformers, etc., shall be connected to a circuit protected by a ground-fault interrupter or shall be effectively grounded with both a grounded system and a flexible copper ground wire.

12.7.2 ***Substitute equipment.*** Whenever practical, air-powered, battery-operated, or hydraulic tools shall be used in wet areas. Under no circumstances shall an employee be permitted to use an electric-powered tool powered by more than 24 volts while standing in water.

12.8 BATTERY CHARGING

12.8.1 ***Requirement.*** Battery charging operations shall be restricted to well-ventilated areas designated for that purpose.

12.8.2 ***Ventilation.*** Ventilation shall be adequate to ensure diffusion of the battery gases and prevent accumulation of an explosive mixture.

12.8.3 ***Nonseal type.*** Batteries of the nonseal type shall be located in enclosures with outside vents, or in well-ventilated rooms, so arranged to prevent the escape of fumes, gases, or electrolyte spray or liquid into other areas. Safety vent caps shall be kept in place during charging.

12.8.4 ***Racks and trays.*** Racks and trays shall be of sufficient strength and treated with an electrolyte resistive coating.

12.8.5 ***Housekeeping.*** Battery storage and charging areas shall be maintained free of combustible materials and scrap. Acid spills shall be promptly cleaned up and safely disposed.

12.8.6 ***Protective equipment.*** Face shields, aprons, and rubber gloves shall be provided for employees handling acids or recharging batteries. (Refer to subsections 8.3 and 8.6 of this manual.)

12.8.7 ***First aid.*** Facilities for quick emergency drenching of the eyes and body shall be provided within 25 feet of a battery charging area.

12.9 HIGH-VOLTAGE LINES

12.9.1 ***Requirement.*** Overhead transmission and distribution lines, erected by the contractor and rated at 600 volts or more, shall be carried on towers or poles, and provide safe clearances over roadways and structures. These lines shall be placed underground in areas where there is extensive use of equipment having the capability of encroachment on the minimum safe clearance distance. All roadway crossovers shall be posted with maximum safe clearance heights.

12.9.2 ***Crossovers.*** When it is necessary to move machinery or equipment under overhead lines in a manner that encroaches on the following minimum safe clearances, the lines shall be deenergized.

Less than 50 kV, 4 feet
50 kV to 345 kV, 10 feet
above 345 kV, 16 feet.

12.9.3 ***Notification.*** Construction operations adjacent to overhead lines shall not be initiated until the respective utility company has been notified and a coordinated plan for protection of the lines and employees is agreed upon. Any overhead powerline shall be considered to be energized unless the owner or operator of the line assures the contractor that it has been deenergized and the line is visibly grounded.

12.9.4 ***Equipment operation adjacent to high-voltage lines (600 volts or over).*** The following requirements shall apply to the operation of equipment near or adjacent to high-voltage lines:

a. Requirement. Operations adjacent to overhead high-voltage lines are prohibited unless one of the following conditions is satisfied.

(1) The utility company or owner of the line ha been notified, the line deenergized and grounded, and positive control measures taken to prevent energization of the line prior to completion of the work.

(2) Equipment, or any part thereof, does no have the capability of coming within the following minimum distances from the energized lines. Adequate barriers or guards may be erected, or the equipment blocked to prevent encroaching on these distances.

Table of nominal system voltage (kV)
for the minimum clearance distance (ft)

kV	Ft	kV	Ft
50 (or less)	10	161	14
69	11	230	16
115	12	345	20
138	13	500	25

Other kV's: use 10 ft plus 0. 4 in/kV (over 50)

b. Exclusion. Aerial lifts with insulated booms, certified for live line barehand maintenance, are excluded from the requirements set forth in paragraph 12.9.4.

c. Posting. A notice of the minimum distances previously listed in subparagraph 12.9.4.a shall be posted in the cabs of all cranes, shovels, backhoes, and related equipment having the capability of contacting high-voltage lines on th construction site.

d. Boom guards and proximity alarms. Cage-type boom guards, insulating links, or proximity alarms may be used on cranes and related equipment. However, the installation and use of suc devices do not satisfy the requirements set forth in subparagraph 12.9.4.a.

12.10 PORTABLE TRAILING CABLES AND TROLLEYS

12.10.1 ***Requirement.*** The installation and protection of trolleys and portable cables rated above 600 volts for supplying power to movable construction equipment such as gantry cranes, mobile cranes, shovels, etc., shall conform to the National Electrical Safety Code standards.

12.10.2 ***Armored or shielded conductors.*** conductors rated at 440 volts or more shall not be used as trailing cables unless they are heavy-duty armored or shielded. Such cables shall be moved only with nonconductive safety tongs; and when rated over 5,000 volts, only tested and approved hot sticks or gloves may be used.

12.11 SAFE CLEARANCE PROCEDURE

12.11.1 ***Requirement.*** A safe clearance procedure shall be established prior to starting work on electrical circuits or equipment. A safe clearance is an operating procedure by which an employee, acting individually or as a representative of a crew, may have a specific circuit(s) or equipment deenergized and held out of service until released by him.

12.11.2 ***Lockout and tagging.*** The safe clearance procedure shall include specific provision for lockout, tagging, disconnecting, and grounding circuits and electrical equipment in order to prevent unauthorized operation.

12.11.3 ***Compliance.*** No employee shall be permitted to work on an electrical circuit(s) or equipment without following the clearance procedure established for the respective circuit(s) or equipment.

12.12 TRANSMITTER TOWERS

12.12.1 ***Requirement.*** Prior to work near transmitter towers where an electrical charge may be induced in the equipment or materials being handled, the transmitter shall be shut down or a test shall be made to determine if induced current is a hazard. The following precautions shall be taken if it is determined that induced current is a potential hazard:

a. Grounds. The equipment shall be effectively grounded to dissipate the induced current. On equipment with rotating booms, the ground shall be attached to the structure supporting the boom.

b. Ground cables. Grounding cables shall be attached to materials being handled by the hoisting equipment. They shall be placed and removed by the use of hot sticks of adequate capacity.

Section 13

SCAFFOLDING

13.1 GENERAL

13.1.1 ***Requirement.*** Scaffolds, platforms, or temporary floors shall be provided for employees engaged in work that cannot be performed safely from the ground or from solid construction. All scaffolding shall be erected under the supervision of a competent person and in compliance with the requirements of this section.

13.1.2 ***Ladders.*** Ladders shall be considered primarily as a means of access, and not as work platforms.

13.1.3 ***Nets, safety lines, and belts.*** Work conditions requiring the use of safety nets, safety lines, and belts are set forth in subsections 8.8, 8.9, and 8.10, and also in other parts of this manual.

13.1.4 ***Footing.*** The footing or anchorage for scaffolds shall be sound, rigid, and capable of carrying the maximum intended load without settling or displacement. Unstable objects such as barrels, boxes, loose brick, or concrete blocks shall not be used to support scaffolds or planks.

13.1.5 ***Safety factor.*** Scaffolds and their components, except for wire or fiber rope suspension, shall be capable of supporting at least four times the maximum intended load. Wire or fiber rope used for scaffold suspension shall be capable of supporting at least six times the maximum intended load.

13.1.6 ***Guardrails.*** Except for floats and needle beam scaffolds, work platforms and scaffolds more than 6 feet above ground or floor level shall be provided with standard guardrails, midrails, and toeboards on the open sides and ends. Scaffolds 4 to 6 feet in height, erected above machinery or other hazard, or having a minimum horizontal dimension in either direction less than 45 inches, shall also be provided with standard guardrails installed on open sides and ends.

13.1.7 ***Scaffold lumber.*** Load carrying members of scaffold framing shall be a minimum of 1,500 fiber (stress grade) construction grade lumber. All dimensions are nominal sizes as provided in the American Lumber Standards, except where rough sizes are noted, only rough or undressed lumber of the full dimension specified will satisfy minimum requirements.

13.2 SCAFFOLD PLANKS

13.2.1 ***Requirement.*** Planking used as working surfaces on scaffolds, platforms, runways, or ramps shall be scaffold grade or equivalent, not less than 2 inches in thickness, and laid with edges flush. All planking shall be secured in place to prevent displacement. The maximum permissible spans for 2 by 10-inch or wider planks shall be as indicated in the following:

	Undressed lumber			Nominal dimension lumber	
Working load (lb/ft^2)	25	50	75	25	50
Permissible span (ft)	10	8	6	8	6

13.2.2 ***Width.*** The width of all scaffolds, ramps, runways, and platforms shall be sufficient to prevent congestion of persons, materials, or equipment, and in no case shall they be less than 18 inches wide.

13.2.3 ***Lapped planking.*** Planking, when lapped, shall overlap each member a minimum of 12 inches.

Scaffold planks shall extend over their bearers not less than 6 inches nor more than 12 inches.

13.2.4 ***Flush planking.*** When installed flush, the butt joint shall be at the centerline of a pole and the plank ends shall be supported by and secured to separate bearers.

13.2.5 ***Intermediate support.*** When necessary to prevent dislodgement or excessive deflection, intermediate support shall be provided.

13.2.6 ***Corner planking.*** When a scaffold materially changes direction, the planks shall be laid and secured in a manner to prevent tipping. Diagonally installed bearers shall be used to support the intended loading and to prevent tipping.

13.2.7 ***Changing levels.*** When moving platforms or planking to another adjacent level, the old planking shall be left in place until the new bearers have been installed.

13.2.8 ***Access.*** An access ladder, stairs, or equivalent safe access shall be provided to all elevated work areas. Ladders, stairs, and ramps shall conform to the requirements set forth in section 14.

13.3 STANDARD GUARDRAILS

13.3.1 ***Design.*** A standard guardrail shall consist of a top rail, intermediate rail, toeboard, and posts. The vertical height of the guardrail shall be approximately 42 inches.

13.3.2 ***Dimension.*** Wooden scaffold posts and top rails shall be a minimum 2- by 4-inch, construction grade or equivalent lumber with posts spaced not to exceed 8 feet on centers. Intermediate rails shall be a minimum of 1 by 6 inches. Toeboards shall be a minimum height of 4 inches installed flush with the planking or floor.

13.3.3 ***Pipe guardrails.*** Posts, toprails, and intermediate rails shall be a minimum 1.5-inch-nominal diameter steel pipe with posts spaced not to exceed 8 feet on centers.

13.3.4 ***Metal guardrails.*** Posts, toprails, and intermediate rails shall be 2- by 2-by 3/8-inch angle iron, or equivalent, with posts spaced not to exceed 8 feet on centers.

13.3.5 ***Guardrail strength.*** Regardless of material used, the guardrail shall be capable of withstanding a a minimum loading of 200 pounds applied in any direction at any point on the top rail with a minimum of deflection. Railings required to withstand greater stress due to the nature of use shall be designed with a minimum safety factor of four.

13.3.6 ***Rope guardrails.*** Synthetic or natural fiber ropes shall not be used as guardrails. Wire rope having equivalent strength of pipe guardrails may be used for top and intermediate rails provided deflection is less than 12 inches under a 200-pound loading at center span.

13.4 HAZARDOUS CONDITIONS

13.4.1 ***Overhead protection.*** Overhead protection shall be provided for employees working on scaffolds exposed to falling objects.

13.4.2 ***Scaffold enclosures.*** Where persons are required to work under scaffolding or the scaffold is above an accessway, the scaffold shall be enclosed on the open side and ends. Also, the space between the decking and the form or wall shall be enclosed. The protective enclosure shall be No. 18 U.S. Standard gage wire, or equivalent, with 0.5 inch or less mesh.

13.4.3 ***Welding, burning, and riveting.*** Welding, burning, riveting, or open flame work shall not be performed on staging suspended by natural fiber or synthetic rope. Natural fiber or synthetic rope staging supports used in the proximity of corrosive materials shall be protected or treated to prevent corrosion.

13.4.4 ***Hoisting equipment.*** Material hoists shall not be mounted on scaffolds or elevated work platforms unless the scaffold or work platform is designed or strengthened to withstand the additional loading.

13.4.5 ***Ladder jacks.*** The use of ladder jacks, lean-to, and prop-scaffolds, is prohibited.

13.5 SCAFFOLD MAINTENANCE

13.5.1 ***Requirement.*** Scaffold and work platforms, including access thereto, shall be routinely checked by competent personnel and maintained in safe condition. Scaffolding or elevated work platforms damaged or weakened in any manner shall be removed or repaired immediately. The contractor shall not permit employees to work from weakened or damaged scaffolding.

13.5.2 ***Unsafe conditions.*** Scaffolds, platforms, and accessways shall be maintained free of ice, snow, grease, mud, and other materials or equipment which would create a slipping or falling hazard. Tools, materials, equipment, or debris shall not be permitted to accumulate on scaffolds, work platforms, or in accessways.

13.5.3 ***Safe footing.*** Where scaffolds, work platforms, or accessways are usually wet or slippery, an abrasive material shall be applied to improve the footing.

13.6 WOOD POLE SCAFFOLDS

13.6.1 ***Design.*** Wood pole scaffolds exceeding 60 feet in height shall be designed by a licensed professional engineer and constructed in accordance with the engineer's design specifications and drawings. Wood pole scaffolds 60 feet or less in height shall be constructed and erected in accordance with the specifications set forth in appendix J, Single and Independent Pole Scaffolds. In addition, wood pole scaffolds shall conform to the general requirements in this subsection.

13.6.2 ***Footing.*** Scaffold poles shall bear on a foundation of sufficient size and strength to spread the load over an area sufficiently large to prevent settlement.

13.6.3 ***Wood poles.*** When wood poles are joined, they shall be spliced, the ends squared, and the members plumbed. Splice plates shall be used on at least two adjacent sides of the joint and shall be capable of developing strength in any direction equal to the spliced members.

13.6.4 ***Independent pole scaffolds.*** Independent pole scaffolds shall be set as close to the wall of the building or structure as possible. Cross bracing shall be set between the inner and outer sets of poles. Refer to appendix K, Independent Wood Pole Scaffold Design.

13.6.5 ***Single pole scaffolds.*** Single pole scaffolds shall be constructed and braced similar to the design illustrated in appendix L, Single Pole Wood-Pole Scaffold Design.

13.6.6 ***Diagonal bracing.*** Field diagonal bracing, as shown in appendixes K and L, shall be erected across the entire face of pole scaffolds in both directions. When it is necessary to splice the braces, it shall be done at the poles.

13.6.7 ***Scaffold support.*** Pole scaffolds shall be securely guyed or tied to the building or structure. When the height or length exceeds 25 feet, the scaffold shall be secured at intervals not greater than 25 feet vertically and horizontally.

13.6.8 ***Putlogs or bearers.*** Putlogs or bearers shall be set with their greater dimension vertical. They shall project over the ledgers of the inner and outer rows of poles at least 3 inches. Every putlog or bearer on a single pole scaffold shall be reinforced with a 3/16- by 2-inch steel strip, or equivalent, over the entire length of its lower edge.

13.6.9 ***Ledgers.*** Ledgers shall be long enough to extend over two pole spaces and shall not be spliced between the poles.

13.6.10 ***Guardrails.*** - Standard guardrails and toeboards shall be installed on all pole scaffolds as set forth in subparagraph 13.1.6.

13.7 OUTRIGGER SCAFFOLDS

13.7.1 ***Design.*** Outrigger scaffolds shall be constructed similar to the design illustrated in appendix M, Outrigger Scaffold Design, and shall conform to the specific requirements of this subsection.

13.7.2 ***Dimensions.*** Single level outrigger scaffolds shall be constructed to conform with the minimum lumber dimensions and maximum spacing listed in table 13-1.

Table 13-1.—*Minimum nominal size and maximum spacing*

Component	Light duty, 25 lb/ft^2	Medium duty, 50 lb/ft^2
Outrigger size	2 by 10 in.	3 by 10 in.
Outrigger spacing	8 ft	6 ft
Planking	2 by 10 in.	2 by 10 in.

13.7.3 *Outrigger beams*

a. Lumber. Outrigger support beams shall be straight-grained Douglas fir, or equivalent, free of knots.

b. Length. The beams shall not extend more than 6 feet beyond the face of the building or structure and the inboard end shall not be less than 1.5 times the outboard length measured from the fulcrum point.

c. Fulcrum point. At the fulcrum point, the beam shall rest with sides plumb, on a secure bearing at least 6 inches in each horizontal dimension. The beams shall be secured from movement or tipping at the fulcrum point.

d. Inboard ends. The inboard ends of the beams shall be braced and secured to prevent tipping or movement in any direction.

13.7.4 ***Planking.*** Planking shall be laid flush, secured to the beams, and extend to within 3 inches of the wall of the building or structure.

13.7.5 ***Guardrails.*** Standard guardrails and toeboards shall be installed on all outrigger scaffolds.

13.7.6 ***Multiple level.*** When more than one level is to be supported by an outrigger system, the scaffold shall be designed by a licensed professional engineer.

13.8 SUSPENSION SCAFFOLDS

13.8.1 ***General.*** The following requirements apply to the construction and use of all types of suspension scaffolds listed in this subsection.

a. Design. All parts and components of suspension scaffold systems, except the suspension wire ropes, shall be designed and constructed with a minimum safety factor of four.

b. Suspension. Suspension scaffolds shall be supported by wire, synthetic, or fiber ropes with a minimum safety factor of six and secured to outrigger beams. Suspension ropes shall have the fixed ends equipped with a proper size thimble secured by splicing or other equivalent means and attached to the supports by closed-type shackles. Running ends of the suspension ropes shall be securely attached to the hoisting drums, and at least four turns of the rope shall remain on the drum at all times. The suspension ropes shall be attached at the vertical centerline of the outrigger, and the attachment shall be directly over the hoisting drum.

c. Outrigger beams. Outrigger beams shall be structural steel, equivalent in strength to at least a standard 7-inch, 15.3-pound per foot steel I-beam, and shall be at least 15 feet long. Unless designed by a licensed professional engineer for a specific use, they shall not extend more than 6.5 feet beyond the fulcrum or bearing point. The outrigger beams shall be set with their webs in the vertical position and anchored to the structure by the equivalent of U-bolts and anchor plates, washers, and nuts. The beams shall rest on wood bearing blocks; a stop bolt shall be installed on each end of every beam.

d. Hoisting devices. All suspension scaffolds, except stationary or crane supported, shall be equipped with either manual or powered hoisting machines. The machines shall be either worm geared or powered both up and down, and designed to stop independently of manual braking and not move when power is not being applied. Power units and manually operated winches shall be of a type tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Engineering Corporation.

e. Hoist safety controls. Controls for powered scaffolds shall be of the deadman type with a nonlocking switch or control. A device to shut off the power shall be installed ahead of the operating control. The speed control device shall be designed so that it cannot be manually released.

f. Scaffold brackets. Scaffold brackets shall be wrought iron or mild steel. Reinforcing steel shall not be used as part of the support system.

g. Stability control. Suspension scaffolds shall be controlled by wire rope guides or equivalent means such as taglines to prevent sway. Tiebacks of 3/4-inch manila rope, or equivalent, shall be installed on suspension scaffolds for use as a secondary means of anchorage.

h. Ladder-type platforms. Ladder-type platforms shall be designed and constructed in accordance with appendix N, Specifications For Ladder-Type Platforms. The type of lumber used in construction of the ladder assembly and platform shall be equivalent to:

Use	Type
Side stringers	Straight-grained spruce
Rungs	Straight-grained oak, ash, or hickory

The side stringers shall be tied together with tie rods passing through the stringers and riveted tight against washers on both ends. Flooring strips shall be spaced not more than 5/8 inch apart except at side rails where the space may be 1 inch.

i. Plank-type platforms. Plank-type platforms shall be constructed of not less than nominal 2- by 10-inch unspliced scaffold planks, cleated together on the underside. Cleats shall be installed at not less than 4-foot intervals and within 6 inches of each end. The span between platform hangers shall not exceed 8 feet, and the planking shall not extend more than 12 inches past the end hangers. The platform decking shall be securely fastened to the hangers.

j. Beam-type platforms. Side stringers for beam-type platforms shall be not less than 2- by 6-inch nominal dimension, knot-free lumber set on edge. The flooring shall be supported on 2- by 6-inch cross beams, laid flat and set snugly into the top edge of stringers, at not less than 4-foot intervals. Flooring shall be 1- by 6-inch lumber nailed to the supports and not over 0.5 inch apart. The span between hangers shall not exceed 12 feet.

k. Metal-type platforms. Metal platforms shall not be used unless tested and listed according to

Underwriters Laboratories, Inc. or Factory Mutual Engineering Corporation.

l. Working loads. Not more than two men at a time shall be permitted on a suspension scaffold designed for a working load of 500 pounds. Not more than three men at a time shall be permitted on a suspension scaffold designed for a working load of 750 pounds.

m. Safety belts. Employees using suspension scaffolds shall wear approved-type safety belts attached to a lifeline rigged independent of the scaffold system. The lifeline need not be used if the system has independent wire safety ropes installed at each end of the scaffold with approved grabbing and locking devices. However, each employee will be required to wear a safety belt attached to the scaffold. Belts and lifelines shall meet the requirements of subsection 8.8.

n. Overhead protection. Overhead protection of 3/4-inch exterior plywood or equivalent strength material shall be erected not more than 9 feet above the decking when an overhead hazard exists.

o. Guardrails. Suspension scaffolds shall be equipped with standard guardrails and toeboards on the open side and ends. Patented-type guardrails affording equal protection may be substituted with approval of the Contracting Officer's representative.

p. Testing and maintenance. Suspension scaffolds shall be tested at twice the intended working load prior to use. Anchorage, rigging, and hoisting machines shall be inspected prior to the start of each shift. Scaffolds and hoisting machines shall be maintained in safe operable condition.

13.8.2 *Two-point suspension scaffolds*

a. Platforms. Platforms of two-point suspension scaffolds shall be either ladder type, plank type, beam type, or metal type, constructed in conformance with paragraph 13.8.1. The platforms shall not be less than 20 inches nor greater than 36 inches wide overall. The platform shall be securely fastened to the hangers with U-bolts or other equivalent means.

b. Sheaves and blocks. Sheaves of all blocks, consisting of at least one double and one single block, shall be as specified for the size and type of rope used.

c. Securing to building. At each elevated work station, the scaffold shall be secured to the building or structure to prevent sway or movement away from the wall. Window cleaners' anchors shall not be used for this purpose.

13.8.3 *Masons' adjustable multiple-point suspension scaffolds*

a. Working load. The scaffold shall be capable of supporting a working load of 50 pounds per square foot and shall not be overloaded.

b. Single outrigger beam. Where a single outrigger beam is used, it shall have a minimum safety factor of four. The steel shackles or devices with which the suspension ropes are attached to the outrigger beams shall be placed directly over the hoist drums.

c. Guardrail. Masons' suspension scaffolds shall be protected by standard guardrails and toeboards on open sides and ends.

13.8.4 *Stone setters' adjustable multiple-point suspension scaffolds*

a. Loading. The scaffold shall be capable of supporting a working load of 25 pounds per square foot and shall not be overloaded.

b. Platforms. The platform shall be plank type, ladder type, beam type, or metal type securely fastened to the hangers.

c. Guardrails. Stone setters' suspension scaffolds shall be protected by standard guardrails and toeboards on open sides and ends.

d. Multiple use. When two or more scaffolds are used together, they shall not be bridged one to the other, but shall be maintained at the same height with platforms abutting closely.

13.8.5 *Single-point adjustable suspension scaffolds*

a. Suspension. The supporting cable shall be vertical over its entire length, and the basket shall not be swayed nor the cable attached to any intermediate point to change the original path of travel.

b. Multiple use. The units may be combined to form a two-point suspension scaffold providing all requirements of paragraph 13.8.2 are met.

c. Guardrails. Single-point suspension scaffolds shall be protected on all sides with a standard guardrail and toeboard, or equivalent.

13.9 BOATSWAIN'S CHAIRS

13.9.1 ***Seat design.*** The chair seat shall not be less than 12 by 24 inches and 1 inch thick. It shall be reinforced on the underside by cleats to prevent the seat from splitting.

13.9.2 ***Seat slings.*** The seat slings shall be either fiber rope with a minimum diameter of 5/8 inch, or wire rope at least 3/8 inch in diameter. The two slings shall be reeved through the four seat holes so as to cross each other on the bottom of the seat. Boatswain's chairs used for cutting, welding, or other heat producing operations shall be constructed with wire rope slings.

13.9.3 ***Safety belts.*** Employees using boatswain's chairs shall be protected by safety belts and lifelines meeting the requirements of subsection 8.8.

13.10 FLOAT OR SHIP SCAFFOLDS

13.10.1 ***Platform design.*** The platform shall not be less than 3 feet wide and 6 feet long, constructed of 3/4-inch plywood equivalent to American Plywood Association Grade B-B, Group I, exterior, or material of equivalent strength.

13.10.2 ***Platform bearers.*** The underside of the platform shall be reinforced by two supporting bearers of at least 2- by 4-inch or 1- by 10-inch nominal dimensions, knotfree, "select lumber." The bearers shall project 6 inches beyond the platform sides and the ends of the platform shall extend 6 inches beyond the outer edges of the bearers. The platform shall be securely fastened to the bearers.

13.10.3 ***Platform edging.*** A wood edging not less than 0.75 by 1.5 inches shall be placed around the four sides of the platform.

13.10.4 ***Support ropes.*** The ropes supporting the platform shall be not less than 1-inch-diameter manila rope or equivalent, free from deterioration, chemical damage, flaws, or other imperfections. Rope connections shall be such that the platform cannot shift or tip. If two ropes are used to support a float, they shall be arranged to provide four ends which shall be securely fastened to an overhead support. Each of the two supporting ropes shall be hitched around one end of a bearer, passed under the platform, and hitched around the other end of the bearer, leaving sufficient rope at each end for the supporting ties.

13.10.5 ***Loading.*** Not more than three men with a few light tools shall occupy a float at any one time.

13.10.6 ***Safety belts.*** Employees using float or ship scaffolds shall be protected by safety belts and lifelines meeting the requirements of subsection 8.8.

13.11 NEEDLE BEAM SCAFFOLDS

13.11.1 ***Needle beam design.*** Wood needle beams shall not be less than 4 by 6 inches with the greater dimension placed in the vertical position. Steel beams shall be of equivalent strength. The beams shall not be altered or moved horizontally while in use.

13.11.2 ***Supports.*** Ropes or metal hangers, with a safety factor not less than six, shall be provided for supports. Rope supports shall be equivalent to 1-inch-diameter, first-grade manila rope. The span between needle beam supports shall not exceed 10 feet. The support ropes shall be attached to the beams with a scaffold hitch or eye splice, in a manner to prevent the beam from rolling or being displaced. The loose end of the ropes shall be secured by a bowline knot or by a round turn and a half hitch.

13.11.3 ***Platforms.*** The platform span between needle beams shall not exceed 8 feet when using 2-inch scaffold plank or equivalent strength decking material securely fastened to the beams. For spans exceeding 8 feet, the beams, support ropes, or brackets, and the platform shall be designed by a licensed professional engineer. The platform shall not extend beyond the beams less than 6 inches nor more than 12 inches.

13.11.4 ***Safety belts.*** Employees working on needle beam scaffolds shall be protected by safety belts and lifelines meeting the requirements of subsection 8.8.

13.12 HORSE SCAFFOLDS

13.12.1 ***Minimum dimension.*** Minimum dimensions for horse scaffolds are listed in the following table:

Table 13-2.—*Minimum dimensions for horse scaffolds*

Member	Dimension
Horizontal members or bearers	3 x 4 inches
Legs	1.25 x 4.5 inches
Longitudinal leg braces	1 x 6 inches
Gusset joining legs	1 x 8 inches
Half diagonal braces	1.25 x 4.5 inches

13.12.2 ***Maximum height.*** Horse scaffolds shall not be constructed nor arranged more than two tiers or 10 feet in height. When arranged in tiers, each horse shall be placed directly over the horse below and securely fastened to the planking or platform.

13.12.3 ***Maximum span.*** The platform span between horses shall not exceed 5 feet for medium duty nor more than 8 feet for light duty.

13.12.4 ***Guardrails.*** Horse scaffolds over 6 feet in height shall be protected by standard guardrails and toeboards on open sides and ends.

13.13 BRICKLAYERS' SQUARE SCAFFOLDS

13.13.1 ***Minimum dimension.*** Minimum dimensions for bricklayers' square scaffolds are listed in the following table.

Table 13-3.—*Minimum dimensions for bricklayers' square scaffolds*

Member	Dimension
Horizontal members or bearers	2 x 6 inches
Legs	2 x 6 inches
Corner braces	1 x 6 inches
Diagonal braces from center frame	1 x 8 inches

13.13.2 **Bracing.** The squares shall be reinforced on both sides of each corner with 1- by 6-inch wood gussets or equivalent strength metal. They shall also be diagonally braced on both sides by 1- by 8-inch wood braces or equivalent strength braces.

13.13.3 ***Multiple squares.*** The squares shall be set not more than 5 feet apart on medium duty scaffolds nor more than 8 feet apart on light duty scaffolds. Adjoining squares shall be braced with 1- by 8-inch wood or equivalent braces, extending from the bottom of each square to the top of the next square. Diagonal bracing shall be installed on all four sides of squares arranged for multiple use.

13.13.4 ***Platform planks.*** Platform planks shall be at least 2- by 10-inch nominal dimension. The ends of the planks shall overlap the bearers of the squares 6 to 12 inches; in multiple use, each plank shall be supported by not less than three squares.

13.13.5 ***Maximum height.*** Bricklayers' square scaffolds shall not exceed 5 feet in height nor be less than 5 feet in width. The scaffolds shall not exceed three tiers in height and be constructed so that each square will be directly above the other. The upper tiers shall set firmly on the platform or planking of the next lower square and be nailed or otherwise secured to prevent displacement.

13.14 CARPENTERS' BRACKET SCAFFOLDS

13.14.1 ***Bracket design.*** The brackets shall consist of a triangular frame constructed of not less than 2- by 8-inch cross section lumber or metal of equivalent strength. Each member shall not exceed 30 inches in length and shall be fitted and securely joined to the adjoining member.

13.14.2 ***Attachment.*** Each bracket shall be attached to its structural support by one of the following methods.

a. A 5/8-inch-minimum-diameter bolt extending through the wall or structural support.

b. A metal stud attachment device which provides a safety factor of at least four.

c. Welding to a steel tank or metal structural member.

d. Hooking over a structural support member.

13.14.3 ***Spacing.*** Brackets shall be installed not more than 8 feet on centers.

13.14.4 ***Platform.*** The platform shall consist of not less than 2- by 10-inch-nominal-dimension scaffold planks extending not more than 12 inches nor less than 6 inches beyond each end support.

13.14.5 ***Maximum loading.*** Not more than two persons plus 75 pounds of tools and material shall occupy any 8-foot section of the scaffold at one time.

13.14.6 ***Guardrails.*** Carpenters' bracket scaffolds over 6 feet in height shall be protected by standard guardrails and toeboards on the open sides and ends.

13.15 PLASTERERS', DECORATORS', AND LARGE AREA SCAFFOLDS

13.15.1 ***Requirement.*** Plasterers' latherers', decorators', and ceiling workers' scaffolds shall be constructed in accordance with the specifications and requirements for wood pole scaffolds set forth in subsection 13.6.

13.15.2 ***Sections.*** When these scaffolds are erected in sections, the sections shall be provided with connecting runways equipped with standard guardrails and toeboards.

13.15.3 ***Guardrails.*** Scaffolds over 6 feet in height shall be protected by standard guardrails and toe boards on open sides and ends.

13.16 INTERIOR HUNG SCAFFOLDS

13.16.1 ***Support.*** Interior hung scaffolds shall be hung or suspended from the roof structure or from ceiling beams capable of supporting at least four times the intended load.

13.16.2 ***Rope suspension.*** The suspending wire or fiber rope shall be capable of supporting at least six times the working load. The rope shall be wrapped at least twice around both the support members and the scaffold bearers, with the wire rope ends secured with at least three properly installed wire rope clips.

13.16.3 ***Wood scaffold dimensions.*** The following minimun nominal dimension material shall be used for constructing hanging wood scaffolds:

a. Support bearers, 2 by 10 inches on edge, supported at not less than 8 foot intervals of length.

b. Planking, 2 by 10 inches with a maximum span of 6 feet for heavy duty and 8 feet for medium or light duty.

13.16.4 ***Steel tube and coupler members.*** Steel tube and coupler members may be used for hanging scaffolds providing the scaffold system is designed to support a uniform distributed working load of 50 lb/ft^2 with a safety factor of four.

13.16.5 ***Guardrails.*** Interior hung scaffolds over 6 feet above the floor shall be protected by standard guardrails and toeboards on all open sides and ends.

13.17 WINDOW JACK SCAFFOLDS

13.17.1 ***Design.*** Only approved patented-type metal window jack scaffolds may be used.

13.17.2 ***Restricted use.*** Window jack scaffolds shall be used only for the purpose of working at the window opening through which the jack is placed. They shall not be used to support planks or platforms extending from one window to another.

13.17.3 ***Maximum loading.*** Not more than one person shall occupy a window jack scaffold at any one time.

13.17.4 ***Guardrails.*** Window jack scaffolds shall be equipped with standard guardrails unless safety belts and lifelines are available and used by the employee.

13.18 PUMP JACK SCAFFOLDS

13.18.1 ***Loading.*** Pump jack scaffolds and their components shall not be loaded in excess of the manufacturer's recommended limits. Working loads exceeding 500 pounds shall not be imposed on these scaffolds.

13.18.2 ***Design.*** Pump jack brackets, braces, and accessories shall be fabricated from metal plate and angles. Each pump jack bracket shall have two positive gripping mechanisms to prevent failure or slippage.

13.18.3 ***Platforms.*** When wood scaffold planks are used as platforms, the poles used for pump jacks shall not be spaced more than 10 feet on centers. When fabricated platforms are used, pole spacing may be increased but should not exceed the manufacturer's recommendation. In all installations, a safety factor of four shall be maintained.

13.18.4 ***Poles.*** Poles shall not exceed 30 feet in height and be capable of supporting four times the intended loading. Poles shall be secured to the work wall by rigid triangular bracing or equivalent, installed at the bottom, top, and other points as necessary to provide a maximum vertical spacing not more than 10 feet between braces. Each brace shall be capable of supporting at least 225 pounds in tension and compression. Temporary bracing shall be used when the bracket is being raised.

13.18.5 ***Restrictions.*** Not more than two persons shall be permitted between any two supports at one time.

13.18.6 ***Guardrails.*** Unless employees are required to use safety belts and lifelines, pump jack scaffolds shall be provided with standard guardrails.

13.19 METAL SCAFFOLDS AND TOWERS

13.19.1 ***Requirement.*** All metal scaffolds and towers shall be, or equivalent to, those listed by Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation. Such scaffolds and towers shall be erected in accordance with the manufacturer's specifications and the design load limits shall not be exceeded.

13.19.2 ***Access.*** Metal scaffolds and towers shall be provided with access ladders or stairways conforming to section 14.

13.19.3 ***Erection.*** Sections of metal scaffolds shall be set plumb and securely connected together. All braces shall be installed prior to scaffold use. The entire scaffold shall be secured and braced to the building or structure at intervals not exceeding 30 feet horizontally and 26 feet vertically. Free-standing scaffold working platform heights shall not exceed three times the smallest base dimension.

13.9.4 ***Platforms and planking.*** Work platforms and planking shall be firmly secured at both ends to the bearers. Planks shall extend over their end supports not less than 6 inches nor more than 12 inches.

13.19.5 ***Guardrails.*** Metal scaffolds and towers shall be enclosed on open side and ends with standard guardrails and toeboards.

13.19.6 ***Tube and coupler scaffolds***

a. Design. Tube and coupler scaffolds shall be designed and constructed to the specifications set forth in appendix O, Tube and Coupler Scaffolds; and in accordance with the requirements of this paragraph. Scaffolds exceeding the height limitations set forth in appendix O, shall be designed by licensed professional engineers.

b. Minimum dimensions. The components of tube and coupler scaffolds shall be constructed of steel tubing not less than the respective minimum diameters and spacing indicated in the following table.

Table 13-4—*Tube and component scaffold minimum dimensions*

Component	Duty		
	Light	Medium	Heavy
Posts, runners, and bracing diameter	2-inch o.d.	2-inch o.d.	2-inch o.d.
Bearer diameter	2-inch o.d.	2.5-inch o.d.	2.5-inch o.d.
Max. post spacing (length)	10 feet	8 feet	6.5 feet
Max. post spacing (width)	6 feet	6 feet	6 feet

NOTE: Other spacing dimensions or other structural-type components, when used, shall be designed to support an equivalent load. No dissimilar metals shall be used on the same scaffold frame.

c. Bearers. Bearers shall be at least 4 inches, but not more than 12 inches longer than the post or runner spacing. Bearers shall be installed transversely between posts and shall be securely coupled to the posts bearing on the runner coupler. When coupled directly to the runners, the coupler must be kept as close to the posts as possible.

d. Runners. Runners shall be spaced not more than 6.5 feet on centers. The bottom runners shall be located as close to the base as possible.

13.19.7 *Tubular welded frame scaffolds*

a. Design. Metal tubular frame scaffolds, including all load-bearing components, shall be designed and constructed to safely support four times the maximum rated load. The frames shall be placed one directly over the other using coupling or stacking pins to provide vertical alinement of the posts.

b. Height limitation. A licensed professional engineer shall prepare drawings and specifications for metal frame scaffolds exceeding 125 feet in height.

13.19.8 *Mobile scaffolds*

a. Maximum height. The height of free-standing mobile scaffolds shall not exceed four times the minimum base dimension.

b. Casters. Wheels and casters shall be equipped with a positive locking device to prevent accidental movement of the scaffold.

c. Moving. The force necessary to move mobile scaffolds shall be applied as close to the base of the scaffold as possible. Provisions shall be made to stabilize the scaffold during movement. The scaffolds shall be used only on firm, level, and broom-clean surfaces.

d. Riding. No person shall be permitted to ride on a manually propelled mobile scaffold unless the following conditions exist:

(1) The floor or surface is within 3° of level and free from pits, holes, or obstructions.

(2) The minimum dimensions of the scaffold base when ready to move is at least one-half the height.

(3) Outriggers, if used, shall be installed on both sides of staging.

(4) The wheels or coasters are equipped with rubber or similar resilient tires.

(5) Tools and materials are removed from the platform or secured prior to movement.

13.20 ELEVATING AND ROTATING WORK PLATFORMS

13.20.1 ***Requirement.*** Elevating and rotating work platforms shall be designed and used in conformance with the standards set forth in ANSI A92.2, "Vehicle Mounted Elevating and Rotating Work Platforms," and subsection 18.12 of this manual.

13.21 FORM SCAFFOLDS

13.21.1 ***Design and construction.*** Form scaffolds shall be designed and erected with a minimum safety factor of four, computed on the basis of the maximum rated load. Load carrying wood members of the scaffold framing, planking, and guardrails shall comply with minimum requirements of paragraph 13.1.7. Lumber and steel used in the construction of support brackets for form scaffolds shall conform to the dimensions set forth in this subsection for the specific type of scaffolding.

13.21.2 ***Scaffold planking.*** Planking used on form scaffolds shall comply with the requirements set forth in subsection 13.2.

13.21.3 ***Guardrails.*** Standard guardrails and toeboards meeting the requirements set forth in subsection 13.3 shall be installed on the open sides and ends of all form scaffolds exceeding 6 feet in height.

13.21.4 ***Figure-four form scaffolds***

a. General. Figure-four form scaffolds are intended for light duty and shall not be used to support loads exceeding 25 lb/ft^2 unless specifically designed for greater loading.

b. Design. Figure-four form scaffolds shall be designed and constructed as illustrated in appendix P, Figure-Four Form Scaffold, incorporating the dimensions set forth in the following table.

Table 13-5.—*Figure-four scaffold dimensions*

Component	Dimension
Upright and guardrail dimension	2 x 4 inches minimum
pright or guardrail spacing	8 feet 0 inch maximum
Guardrail height	Approx. 42 inches
Outriggers or ledgers (two)	1 x 6 inches minimum
Braces (two)	1 x 6 inches minimum
Intermediate guardrail	1 x 6 inches minimum
ax. ledger length	3 feet 6 inches beyond form support member
Planking	2 x 10 inches minimum
Toeboards	4 inches minimum height

c. Attachment to form. - The form scaffold shall be an integral part of the form and nailed or bolted to the form studding as illustrated in appendix P.

13.21.5 *Metal bracket form scaffolds*

a. Design. Metal bracket form scaffolds shall be designed and constructed with a minimum safety factor of four, computed on the basis of maximum rated load. The metal brackets may be of any metal which will support the maximum rated load and shall be constructed similar to the scaffold illustrated in appendix Q, Metal Bracket Form Scaffold. They shall be equipped with standard guardrails and toeboards.

b. Attachment to form. Metal brackets shall be spaced not more than 8 feet apart on centers. They may be an integral part of the form, in which case they shall be bolted or welded to the form, or they can be attached using "clip-on" or "hook-over" brackets, provided the form walers are bolted to the form or secured by snap ties or shea-bolts extending through the form and securely anchored.

c. Folding-type brackets. Folding-type brackets shall be either bolted or secured in the extended position with locking-type pins.

13.21.6 *Wooden bracket form scaffolds*

a. Design and construction. - The minimum design criteria set forth in this paragraph pertains to form scaffolding limited to light duty, and shall not be used to support loads exceeding 25 lb/ft^2 unless specifically designed for greater loading. The scaffolds may be constructed of lumber or metal of equivalent strength, and shall be designed similar to the scaffold illustrated in appendix R, Wooden Bracket Form Scaffold.

b. Minimum dimensions. Minimum dimensions and spacing for wooden bracket form scaffolds shall be as set forth in the following table.

Table 13-6.—*Minimum dimensions for wooden bracket form scaffolds*

Component	Dimensions
Uprights	2 x 4 inches
Support ledgers	2 x 6 inches
Bracing	1 x 6 inches
Guardrails	2 x 4 inches
Intermediate guardrail	1 x 6 inches
Upright or bracket spacing	8 feet on centers (maximum)
Toeboards	4 inches minimum height

c. Scaffold width. Scaffold width shall not be less than 2 feet nor greater than 3.5 feet, and the walkway shall be at least two scaffold planks wide.

13.22 ROOFING PROTECTION

13.22.1 ***Requirement.*** During construction, demolition or repair, and maintenance of roofs, adequate protection shall be provided for employees working on or under the roof. Such protection may consist of shingling footlocks, lifelines, safety belts, crawling boards, ladders, guardrails, catwalks, toeboards, temporary decking, or other devices that will furnish adequate protection.

13.22.2 ***Material handling.*** On roofs over 16 feet in height, a hoisting device, stairway, or progressive platforms shall be installed for use in supplying material and equipment. Level landing platforms with guardrails and toeboards shall be provided at the roof level.

13.22.3 ***Crawling boards.*** Crawling boards shall not be less than 10 inches wide and 1 inch thick, with 1- by 1.5-inch cleats spaced at equal intervals not exceeding 24 inches. The cleats shall be equal in length to the width of the crawlboard and secured with nails driven through the crawlboard and clinched on the underside. The crawling board shall extend from the ridge pole to the eaves. A securely fastened lifeline of at least 3/4-inch manila rope or equivalent shall be strung beside each crawling board.

13.22.4 ***Catch platforms***

a. Requirement. Employees working on unprotected roofs more than 16 feet from ground to eaves with a slope greater than 1:4 are required to wear safety belts attached to lifelines, or a catch platform shall be installed.

b. Design. The catch platform shall extend from the perimeter 2 feet beyond the projection of the eaves and shall be provided with a standard guardrail and toeboard.

13.22.5 ***Roofing brackets.*** Roofing brackets shall be secured in place by nailing in addition to the use of metal projections. When it is impractical to nail the brackets, rope supports consisting of 3/4-inch manila rope or equivalent shall be used.

13.23 CRANE SUPPORTED SCAFFOLDS (MAN-SKIPS)

13.23.1 ***Requirement.*** Crane supported scaffolds are restricted to use in emergencies or where there is no other practical method of performing the work. They shall only be used when specifically authorized by the Contracting Officer's representative, and only in accordance with the requirements of this paragraph.

13.23.2 ***Scaffold design.*** The scaffold shall be constructed of metal having a safety factor of four, computed on the basis of the maximum rated load. The scaffold shall be provided with a standard pipe or metal guardrail, and toeboard enclosing the four sides, and solid material or expanded metal screen from top of the handrail to skip floor.

13.23.3 ***Suspension.*** The scaffold shall be suspended by four independent ropes, each capable of supporting the maximum load. The suspension cables shall be attached to the scaffold by shackles or thimbles and clips and to the loadline or hook with a shackle or positive clamping device. A swivel shall be placed ahead of the connection to prevent rotation.

13.23.4 ***Taglines.*** Guy lines or taglines shall be used to stabilize and control the scaffold.

13.23.5 ***Safety belts.*** Each employee, while on the scaffold, shall wear a safety belt with the line (pigtail) attached to the scaffolding.

13.23.6 ***Crane.*** Cranes used to support scaffolds shall be equipped with planetary or worm gears, torque converters, automatic braking systems, or other equivalent systems that prevent the boom hoist and loadlines from being placed in a freewheeling or neutral position controlled by manual brake operation only. Further, scaffolds will not be lifted by means of a jib attachment and maximum load will not exceed the crane capacity in any obtainable boom configuration. The crane will be rigged to support four times the maximum scaffold loading, and the loadline will be equipped with a limit switch to prevent the hook block from being pulled into the boom head.

13.23.7 ***Supervision.*** Use shall be restricted to strictly controlled conditions and under constant supervision of a general foreman or superintendent.

Section 14
LADDERS, STAIRWAYS, AND RAMPS

14.1 LADDERS

14.1.1 ***Requirement.*** Except where either permanent or temporary stairways, ramps, man hoists, or runways are provided, ladders meeting the requirements of this subsection shall be used to provide access to all elevations. Ladders are primarily a means of access, and may be used as work platforms only when use of small handtools or the handling of light material is involved.

14.1.2 ***Ladder specifications and use.*** The design, construction use, and maintenance of ladders shall comply with the standards published in the current edition of: ANSI A14.1, "Portable Wood Ladders;" ANSI A14.2, "Portable Metal Ladders;" ANSI A14.3, "Fixed Ladders;" and ANSI A14.4, "Job Made Ladders."

14.1.3 ***Foundation.*** Ladders shall rest on firm foundation capable of supporting the load without displacement in any direction.

14.1.4 ***Pitch.*** The slope or pitch of portable ladders shall not exceed 1 foot of horizontal distance for each 4 feet of vertical rise; i.e., the minimum acute angle with the horizon must not be less than 76°.

14.1.5 ***Securing ladders.*** With exception of portable stepladders, all ladders shall be secured at the top and at such intermediate positions necessary to maintain them rigidly in place and to support the loads imposed on them.

14.1.6 ***Location.*** Ladders shall not be placed in accessways, doorways, or other locations where they may be displaced unless protected by barricades or guards. The area immediately adjacent to the top and bottom of a ladder shall be kept free of debris, materials, equipment, or other obstruction.

14.1.7 ***Side rails.*** The side rails shall extend not less than 36 inches above the landing, unless grabrails of equal height are provided at the top of the ladder.

14.1.8 ***Electrical hazard.*** Portable metal ladders shall not be used for any electrical work or permitted in substations, powerplants, pumping plants, or in any area where contact can be made with energized circuits of 600 volts or greater.

14.1.9 ***Stepladders.*** Portable stepladders shall not exceed 20 feet in height.

14.1.10 ***Fixed ladders.*** Fixed ladders shall be designed, constructed, and installed in accordance with ANSI A14.3, "Fixed Ladders," and the following provisions.

a. Toe space. At least 7 inches toe space shall be provided between the inside face of the rungs and wall.

b. Landing. Provision shall be made for a landing at the top of all fixed ladders by extending the side rails, stanchions, or other supports at least 42 inches above the landing.

14.1.11 ***Double-cleat ladders.*** Ladders providing the only means of access to and from a work area for 25 or more employees, or are intended for simultaneous two-way traffic, shall be double cleated. Double-cleat ladders shall not exceed 24 feet in length.

14.1.12 ***Job made wood ladders.*** Job made wood ladders shall comply with the following construction specifications:

a. Single-cleat ladders. Single-cleat ladders shall be constructed as illustrated in appendix S, Single-Cleat Ladder Design. Lumber for side rails and cleats shall be knot free, at least 1,500-fiber, construction grade or equivalent.

b. Double-cleat ladders. Middle and side rails 12 feet or less in length shall be at least 2- by 4-inch nominal dimension; and from 12 to 24 feet, the rails shall be 2- by 6-inch nominal dimension. Cleats shall not exceed 30 inches in length and be at least 1- by 4-inch nominal dimension.

c. Cleats. Cleats shall be inserted 0.5-inch deep in side rails or filler blocks shall be used to support the cleats. Cleats shall be uniformly spaced 12 inches top to bottom and secured to the rails with at least three 10d common wire nails, or fasteners of equivalent strength.

14.1.13 ***Ladder height.*** No fixed ladder shall exceed 20 feet in height, unless one of the following requirements is met.

a. Climbing safety device. Installation of a ladder climbing safety device complying with Federal Specification RR-S-001301.

b. Off-set platforms. Installation of offset landing platforms, protected by standard guardrails and toeboards, at vertical distances not exceeding 20 feet.

c. Ladder safety cages. Installation of approved ladder safety cages the full length of the ladder, with offset landing platforms at vertical distances not exceeding 30 feet.

14.1.14 ***Maintenance.*** Provision shall be made for routine inspection and maintenance of all ladders. Broken or damaged ladders shall be promptly repaired or removed and destroyed.

14.2 STAIRWAYS

14.2.1 ***Requirement.*** Temporary or permanent stairways shall be provided to work areas of buildings or structures 20 feet or more in height. This provision does not apply to access of work areas such as scaffolds and work platforms where it is established practice to use ladders. However, stairways shall be constructed for access to fixed scaffolds, walkways, and work platforms affixed to buildings and structures for access over extended periods of construction, e.g., walkways at various levels across the upstream face of a concrete dam under construction.

14.2.2 ***Design.*** Temporary stairways shall not exceed an angle of 50° from the horizontal, and the risers shall be uniform in height, and treads of uniform width. No flight of stairs shall have an unbroken rise of more than 12 feet without a landing extending not less than 30 inches in the direction of travel.

14.2.3 ***Construction.*** Temporary stairways and handrails shall be constructed of selected materials, free of imperfections and hazardous projections, and shall be rigidly supported. Stair treads shall be securely fastened in place.

14.2.4 ***Stair railings and handrails.*** Stairs having four or more risers shall be equipped with standard railings and standard handrails as specified in the following:

a. Less than 44 inches wide and both sides enclosed: at least one handrail on right side descending.

b. Less than 44 inches wide and one side open: one stair railing on the open side.

c. Less than 44 inches wide and both sides open: a stair railing on each side.

d. More than 44 inches but less than 88 inches wide: one handrail on each enclosed side and a stair railing on each open side.

e. More than 88 inches wide: same as subparagraph d, plus a standard stair railing located midway of the width.

14.2.5 ***Standard stair railing.*** Standard stair railings shall be constructed to the specifications set forth for standard guardrails in subsection 13.3, Standard Guardrails, except that no toeboard is required and the vertical height shall be not more than 34 inches nor less than 30 inches, measured from top of the forward edge of the tread to the upper surface of the top rail.

14.2.6 ***Standard handrail.*** A standard handrail shall be securely mounted on the wall or partition, and shall be the same height as the top rail of a standard stair railing. Material and strength requirements shall be equivalent to the stair railing and it shall be mounted at least 3 inches from the wall or partition.

14.2.7 ***Metal pan stairs.*** Where permanent metal pan stairs are set for temporary use, treads of wood filler pieces shall be installed flush with the pan rims.

14.2.8 ***Stairwells and platforms.*** Stairwells and platforms shall be protected on all open sides with standard guardrails and toeboards.

14.2.9 ***Maintenance.*** Stairways shall be routinely maintained and debris and materials shall not be permitted to accumulate on stairs. Slippery conditions shall be eliminated as they occur.

14.3 RAMPS

14.3.1 ***Requirement.*** Temporary access ramps, protected by standard stair railings and handrails, may be substituted for stairways when the slope or incline does not exceed 10°.

14.3.2 ***Design.*** Ramps shall be designed with a safety factor of at least four. Vehicle trestles, ramps, and bridges on which foot traffic is permitted shall be provided with a suitable walkway and guardrail outside of the roadway. Roadway ramps shall be protected with timbers or curbs not less than 8 inches high, secured to each side of the roadway.

14.3.3 ***Overhead protection.*** Overhead protection shall be provided as needed to protect the public, employees, or property from falling objects. The overhead protection shall be of sufficient strength to withstand the potential impact and shall be installed not less than 7 feet nor more than 9 feet above the ramp.

Section 15
FLOOR AND WALL OPENINGS

15.1 FLOOR AND ROOF OPENINGS

15.1.1 ***Requirement.*** Floor and roof openings, including skylights, into which persons can fall shall be covered with material and bracing of sufficient strength to support the load which may be imposed; or they shall be protected by a securely anchored enclosure meeting the requirements of this subsection.

15.1.2 ***Protective enclosure.*** All uncovered floor or roof openings shall be enclosed on open sides with a standard guardrail and toeboard constructed as set forth in subsection 13.3.

15.1.3 ***Stairway and ladderway openings.*** Stairway and ladderway floor openings shall be guarded by a standard guardrail and toeboard on exposed sides except the entrance. Entrances to stairways or ladderways shall be offset or provided with a gate to prevent persons from walking directly into the opening.

15.1.4 ***Hatchways and chute openings.*** Hatchways and chute floor openings shall be guarded by one of the following:

a. Hinged covers of sufficient strength and a standard guardrail and toeboard with one exposed or open side. When the hatchway or chute opening is not in use, the cover shall be closed or the exposed side guarded by a removable standard guardrail.

b. A removable standard guardrail or self-closing gate installed on not more than one side, and fixed standard guardrails and toeboards on all other exposed sides. The removable guardrails shall be kept in place when the opening is not in use. Chute openings into which debris is manually dumped shall be guarded by a standard guardrail on the side on which employees stand to dump debris.

c. Removable standard guardrails secured to the floor on all open or exposed sides; installed to permit removal of only a section or side(s) sufficiently large to perform the work. When the hatchway is not in use, the guardrail shall be immediately replaced and secured.

15.1.5 ***Doors and gates.*** Where doors or gates open directly on a stairway, a platform shall be provided and the swing of the door or gate shall not reduce the effective length of the platform to less than 20 inches.

15.2 WALL OPENINGS

15.2.1 ***Requirement.*** Wall openings, from which there is a drop of more than 4 feet and the bottom of the opening is less than 3 feet above the working surface, shall be guarded with a standard guardrail or guardrail components to afford protection to a height of 42 inches above the working surface. A standard toeboard shall be provided where the bottom of the wall opening is less than 4 inches above the working surface.

15.2.2 ***Extension platforms.*** Extension platforms outside of wall openings, erected to provide access for materials, equipment, or personnel, shall be protected on exposed sides by a standard guardrail and toeboard.

15.3 OPEN FLOORS, ROOFS, AND PLATFORMS

15.3.1 ***Requirement.*** The perimeters of all floors, platforms, etc., 6 feet or more above adjacent floor or ground level shall be guarded by the installation of standard guardrails, or equivalent guarding unless or until they are permanently enclosed to a height of 3 feet or more above the floor or working surface. Standard toeboards shall be provided when there is a hazard to persons or property from falling objects. The perimeters of roofs shall be protected by guardrails or other protective devices as set forth in paragraph 13.22.1.

15.3.2 ***Hazardous locations.*** In locations where a hazardous condition exists, such as projecting reinforcing steel, moving equipment, or hazardous materials, standard guardrails shall be provided regardless of height.

15.3.3 ***Protection from falling objects.*** When employees are required to work under an open-sided wall opening or platform where a hazard from falling objects exists, the contractor shall install appropriate and effective protection such as enclosed guardrails or nets as described in subsections 13.3 and 8.10, respectively.

15.3.4 ***Removal of guardrails.*** The guardrails shall only be removed concurrent with the erection of the permanent wall, and the openings kept as small as possible considering the nature of the work and the safety of the employees.

Section 16
HANDTOOLS, POWERTOOLS, AND JACKS

16.1 GENERAL

16.1.1 ***Maintenance.*** Handtools, powertools, and jacks shall be maintained in safe operating condition and used only for the purpose which they were designed. Damaged and defective tools shall be repaired or removed from service.

16.1.2 ***Storage.*** Tools shall not be left on scaffolds or elevated work spaces, and containers shall be provided for handtools on the jobsite.

16.1.3 ***Guarding.*** Tools designed to accommodate guards shall be operated with such guards in place. Belts, gears, shafts, pulleys, sprockets, spindles, drums, and other type moving drives shall be isolated or guarded as set forth in the current edition of ANSI B15.1, "Safety Code for Mechanical Power-Transmission Apparatus."

16.1.4 ***Grounding.*** Electric-powered tools shall be double-insulated type or effectively grounded as set forth in subsections 12.4 and 12.5.

16.1.5 ***Switches.*** On-off switches controlling the operation of hand-held powered tools shall conform to the following requirements:

a. Hand-held powered platen sanders, grinders with 2-inch or less diameter wheels, routers, planers, laminate trimmers, nibblers, shears, scroll saws, and jigsaws with blade shanks 0.25 inch wide or less may be equipped with only a positive on-off control.

b. Hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels exceeding 2 inches in diameter, disk sanders, belt sanders, reciprocating saws, and similar tools shall be equipped with a momentary contact on-off control. They may have a lock-on control provided the power can be shut off by a single motion of the same finger(s) that turns it on.

c. With the exception of concrete vibrators, jackhammers, and similar pneumatic-powered handtools, all other hand-held power tools including chain saws, circular saws, and percussion tools shall be equipped with a constant pressure switch that shuts off the power when pressure is released.

16.1.6 ***Personal protective equipment.*** Handtool and powertool operators shall be provided with and use respective type(s) of personal protective equipment as set forth in section 8.

16.1.7 ***Hazardous conditions.*** Only nonsparking tools shall be used in locations where sources of ignition may cause an explosion or fire. Gasoline-powered tools shall not be used underground or in locations where toxic exhaust gases can accumulate. Impact tools including drift pins, wedges, and chisels shall be kept in a dressed condition or equipped with nonmushrooming heads.

16.2 PNEUMATIC TOOLS

16.2.1 ***Impact tools.*** Pneumatic impact tools shall be operated with safety clips or retainers installed to prevent tools being accidentally discharged from the chuck.

16.2.2 ***Air hoses.*** Air lines exceeding 0.5-inch inside diameter shall be equipped with safety-type couplings and secured with wire or chain at each coupling to prevent whipping in event of failure. A safety device at the source of supply or branch line which will automatically reduce pressure in case of a line failure may be substituted, provided the device is effective in preventing whipping.

16.2.3 ***Operating pressures.*** The manufacturer's safe operating pressure for hoses, pipes, valves, and fittings shall not be exceeded. Defective hoses, valves, and fittings shall be removed from service.

16.2.4 ***Compressed air.*** Compressed air shall not be directed at any part of the body. Compressed air shall not be used for cleaning purposes except when reduced to less than 30 lb/in^2, and the operator protected by personal protective equipment as set forth in section 8. The 30-lb/in^2 requirement does not apply to sand blasting, green cutting, removal of mill scale, cleaning concrete forms, and similar cleaning operations.

16.2.5 ***Care of air hoses.*** Air hoses shall not be used for hoisting or lowering tools. Hoses shall not be laid on ladders, steps, scaffolds, or walkways in a manner creating a tripping hazard.

16.2.6. ***Airless spray guns.*** Airless spray guns of the type which atomize paints and fluids at pressures of 1,000 lb/in^2 or more shall be equipped with automatic or visible manual safety devices which will prevent pulling of the trigger and prevent release of the paint or fluid until the safety device is manually released. In lieu of the above, a diffuser nut to prevent high pressure release when the nozzle tip is removed and a nozzle tip guard to prevent the tip from contacting the operator or other equivalent protection shall be provided.

16.2.7. ***Nailers.*** Pneumatically driven nailers, staplers, and similar equipment provided with automatic fastener feed, which operate at more than 100 lb/in^2, shall have a safety device on the muzzle to prevent the ejection of the fasteners unless the muzzle is in contact with the work surface.

16.3 GRINDING TOOLS

16.3.1 ***Requirement.*** The installation, guarding, use, and care of grinding tools shall comply with the standards set forth in the current ANSI B7.1, "Safety Code for the Use, Care, and Protection of Abrasive Wheels." Grinding tools shall not be used without the safety guards, protective flanges, and tool rests installed and maintained in proper adjustment.

16.3.2 ***Abrasive wheels.*** Abrasive wheels and scratch brush wheels shall not be operated in excess of their rated safe speed. Cracked or defective abrasive wheels shall be removed from service immediately.

16.4 WOODWORKING TOOLS

16.4.1 ***Requirement.*** The installation, guarding, use, and care of power-operated woodworking tools shall comply with the standards set forth in ANSI 01.1, "Safety Code for Woodworking Machinery," current edition.

16.4.2 ***Switches.*** Switches shall be located to enable the operator to cut off the power without leaving his operating position. Fixed power driven tools shall be provided with a disconnect switch that can be locked in the off position.

16.4.3 ***Automatic feed.*** Whenever the nature of the work will permit, automatic feeding devices shall be installed on fixed power driven woodworking tools. Feeder attachments shall have the feed rolls and/or other moving parts guarded to protect the operator.

16.4.4 ***Electrical equipment.*** When automatic restarting would create a hazard, electrically driven equipment shall be controlled with a device which will prevent automatic restarting following a power failure.

16.4.5 ***Push sticks.*** A push stick, block, or similar safe means shall be used for all operations close to high-speed cutting edges.

16.4.6 ***Planers and joiners.*** Planers and joiners shall be equipped with cylindrical cutting heads and fully guarded.

16.4.7 ***Bandsaws.*** Bandsaw blades shall be fully enclosed except at the point of operation.

16.4.8 ***Cleanup.*** Work areas shall be kept clean and a brush provided at each machine to remove sawdust, chips, and shavings.

16.5 POWER SAWS

16.5.1 ***Circular saws.*** Bench-type circular saws shall be equipped with spreaders, anti-kickback devices, and guards that automatically enclose the exposed cutting edges. Portable hand-held circular saws shall be equipped with guards above and below the baseplate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. As the blade is withdrawn, the lower guard shall automatically and instantly return to the covering position.

16.5.2 ***Operating speeds.*** The operating speed shall be permanently marked on all circular saws over 20 inches in diameter or operating speeds over 10,000 peripheral feet per minute. Only blades designed for use at the marked operating speed shall be used. When the saw is retensioned for a different speed, the marking shall be changed to indicate the new speed.

16.5.3 ***Radial arm saws.*** Radial arm saws and swing cut off saws shall be equipped with limit stops which prevent the leading edge of the blade from traveling beyond the edge of the table. These saws shall also be equipped with automatic brakes or automatic return devices.

16.5.4 ***Unattended.*** Power saws shall not be left running unattended.

16.5.5 ***Sawdust collectors.*** Bench-type circular saws and radial saws used for production work shall be equipped with enclosed-type sawdust collectors.

16.5.6 ***Cleanup.*** Scrap and sawdust shall not be permitted to accumulate; the shop area shall be cleaned up at the end of each shift.

16.5.7 ***Defective blades.*** Cracked, bent, or otherwise defective blades shall be removed from service immediately.

16.6 HYDRAULIC-POWERED TOOLS

16.6.1 ***Safe operating pressures.*** The manufacturer's safe operating pressure for hoses, valves, pipes, filters, and fittings shall not be exceeded.

16.6.2 ***Hydraulic fluid.*** Fluid used in hydraulic powered tools shall be fire-resistant type approved under MSHA Schedule 30.

16.7 POWDER-ACTUATED TOOLS

16.7.1 *Requirement.* Powder-actuated tools shall be designed, maintained, and used in accordance with the standards set forth in the current edition of ANSI A10.3, "Safety Requirements for Powder-Actuated Fastening System," and the requirements of this subsection.

16.7.2 *Operator qualification.* Powder-actuated tools shall be operated and serviced only by persons who have been trained and certified in the safe use of such tools. Operators must possess an operator's card issued by a firm or person authorized to issue such cards.

16.7.3 *Unauthorized use.* Safeguards shall be taken to prevent the possession or use of these tools and their charges by unauthorized persons.

16.7.4 *Flammable atmospheres.* Powder-actuated tools shall not be used in explosive or flammable atmospheres.

16.7.5 *Studs and fasteners.* Only powder charges, studs, or fasteners specified by the manufacturer for the specified tool shall be used.

16.7.6 *Safety features.* Tools shall be designed to operate only when pressed against the work surface with a force at least 5 pounds greater than the weight of the tool. They shall be constructed so the tool cannot fire when dropped or during loading or preparation to fire.

16.7.7 *Materials.* Driving into soft or easily penetrated material is prohibited unless the material is backed to prevent complete penetration. Tools shall not be used on very hard or brittle materials such as

cast iron, glazed tile, surface hardened steel, glass block, live rock, face brick, or hollow tile.

16.7.8 ***Use.*** Tools shall not be loaded until just prior to firing. Loaded tools shall not be left unattended. Tools shall not be pointed at any person, and all parts of the body shall be kept clear of the nozzle.

16.7.9 ***Testing.*** Tools shall be tested each day before loading to ensure that the safety devices are in proper working order; the test shall be conducted in accordance with the manufacturer's recommended test procedure.

16.7.10 ***High-velocity tools.*** High-velocity tools shall be used only for those applications where low velocity tools will not meet the job requirements.

16.7.11 ***List of tools and operators.*** The contractor shall submit a list of all powder-actuated tools and names of certified operators to the Contracting Officer's representative prior to use of the tools.

16.8 HAND-POWERED WINCHES AND HOISTS

16.8.1 ***Rated capacity.*** Hand-powered winches and hoists shall be used within the manufacturer's rated capacity, and the capacity shall be legibly marked on the winch or hoist.

16.8.2 ***Cranks.*** The use of hand cranks is prohibited unless the winch or hoist is equipped with positive self-locking dogs. Hand wheels shall not have projecting spokes, pins, or knobs.

16.9 LEVER AND RATCHET, SCREW, AND HYDRAULIC JACKS

16.9.1 ***Capacity.*** The manufacturer's rated capacity shall be legibly marked on all jacks and shall not be exceeded.

16.9.2 ***Overtravel.*** Jacks, of any type, shall have a positive stop to prevent overtravel.

16.9.3 ***Footing and blocking.*** Jacks shall be set on a stable and firm footing, and cribbed or blocked where necessary to prevent settlement or dislodgement. Where there is a possibility of slippage, a wood block shall be placed between the jack and the load.

Section 17
ROPES, SLINGS, CHAINS, AND ACCESSORIES

17.1 GENERAL

17.1.1 ***Standard criteria.*** The "Rigging Manual" published by the Construction Safety Association of Ontario, 74 Victoria Street, Toronto, Ontario, Canada, M5C2A5 has been designated as the "Bureau Rigging Manual." This manual will be used by the Bureau as a guide in determining whether the contractor's rigging practices are safe and in conformance with industry-wide practices. While its use by the contractor is recommended, both as a rigging manual and a training text, contractually, it is advisory in nature and intended only to compliment the safety requirements set forth in this section.

17.1.2 ***Safe usage.*** The use of ropes, slings, and chains shall be in accordance with the safe usage recommendations of the manufacturer, and the recommendations of the equipment manufacturer when used in conjunction therewith.

17.1.3·***Safe working loads.*** The safe working load of ropes, slings, chains, accessories, and rigging equipment shall be determined prior to use. The safe working load shall be observed and shall not be exceeded. Safe working loads for specified types and sizes of rope, slings, chains, and accessories shall be as set forth in this section. For items of rigging used in combination, the safe working load shall be that of the weakest item.

17.1.4 ***Job-fabricated rigging hardware.*** Use of job-fabricated rigging hardware is prohibited unless designed and certified by a licensed engineer qualified in this field, and tested at 125 percent of the rated safe working load.

17.1.5 ***Repair and maintenance.*** The installation, maintenance, and repair of ropes, chains, and slings and rigging accessories shall be repaired only by the manufacturer or in accordance with the manufacturer's instructions and tested at 125 percent of their rated load prior to use.

17.1.6 ***Inspection.*** Rigging used for material handling shall be inspected prior to use on each shift to ensure that it is in good repair and safe to use. Defective equipment shall be immediately removed from service.

17.2 ALLOY STEEL CHAINS

17.2.1 ***Safe working load.*** The safe working load shall not exceed the rated capacities set forth in table H-1, 29 CFR 1926.251. (Refer to appendix BB, tables 1 and 2.)

17.2.2 ***Identification.*** Welded alloy steel chain slings shall have permanently affixed durable identification tags stating size, grade, rated capacity, and sling manufacturer.

17.2.3 ***Accessories.*** Hooks, rings, links, or other attachments when used with alloy steel chains shall have a rated capacity at least equal to that of the chain. Job-made hooks, links, or makeshift fasteners, formed from bolts, rods, etc., shall not be used.

17.2.4 ***Impact loading.*** Chains shall not be subjected to impact loading or jerking.

17.2.5 ***Excessive wear.*** Whenever wear at any point in any chain link exceeds that shown in the following table, the chain shall be removed from service.

Table 17-1.—*Maximum allowable chain link wear*

Link diameter	Maximum allowable wear	Link diameter	Maximum allowable wear
1/4 inch	3/64 inch	1 inch	3/16 inch
3/8 inch	5/64 inch	1-1/8 inches	7/32 inch
1/2 inch	7/64 inch	1-1/4 inches	1/4 inch
5/8 inch	9/64 inch	1-3/8 inches	9/32 inch
3/4 inch	5/32 inch	1-1/2 inches	5/16 inch
7/8 inch	11/64 inch	1-3/4 inches	11/32 inch

17.3 WIRE ROPE

17.3.1 ***Safe working load.*** The safe working load for various specified sizes and classification of improved steel wire rope and wire rope slings shall not exceed the rated capacities set forth in tables H-3 through H-14, 29 CFR 1926.251. (Refer to appendix BB, tables 3 through 14.) A minimum safety factor of five shall be used in computing safe working loads for wire rope and wire rope sling not specifically identified in the referenced tables.

17.3.2 ***End fasteners.*** Only commercial wire rope fittings shall be used, and they shall be installed as specified in appendix T, Wire Rope Clips. Job-fabricated eye splices shall be made in accordance with the manufacturer's instructions and tested prior to use. An eye splice shall have not less than three full tucks. When a wedge socket fastener is used, the dead or short end of the rope should either have a clip attached to it, or be looped back and secured to itself by a clip.

17.3.3 ***Protruding ends.*** Protruding ends of strands in splices on slings and bridles shall be covered or blunted.

17.3.4 ***Hoisting rope.*** Except for end fasteners, wire rope used in hoisting, lowering, or pulling loads shall consist of one continuous run without knots or splices.

17.3.5 ***Prohibited fastenings.*** Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots. Wire rope clips shall not be used to splice wire rope.

17.3.6 ***Spooling of rope.*** Wire rope shall be correctly overwound or underwound from right to left or left to right in accordance with the lay to avoid twisting, spreading, or overlapping on winch drums.

17.3.7 ***Sheave diameter.*** The ratio between the rope diameter and the drum or sheave diameter shall not be less than specified by the equipment manufacturer. When not specified, the ratio shall be such that the rope will adjust itself to the bend without excessive wear or deformation. Drums, sheaves, and pulleys shall be smooth and free of defects which could damage the rope.

17.3.8 ***Sheave groove tolerance.*** Sheave groove tolerances shall be as recommended by the manufacturer of the sheave, block, drum, or pulley.

17.3.9 ***Lubrication.*** Wire rope shall be lubricated with manufacturer-approved lubricants at intervals warranted by the type of service.

17.3.10 ***Removal and replacement.*** Wire rope with one or more of the following defects shall be removed from hoisting or load carrying service immediately.

a. Corrosion. Corrosion resulting from acids or alkalies. Rust film which has not resulted in pitting or loss of more than one-third of the original wire diameter should be removed and the rope lubricated.

b. Broken wire

(1) One or more valley breaks. (A valley break is a wire break occurring in the valley between two adjacent strands.)

(2) Six randomly broken wires in one wire rope lay or three broken wires in one strand in any one lay.

c. Abrasion. Abrasion, scrubbing, flattening, or peening resulting in loss of more than one-third the original diameter of the outside wires.

d. Kinking. Kinking, crushing, bird caging, or other damage resulting in distortion of the rope structure.

e. Heat damage. Evidence of heat damage resulting from a torch, excessive friction, or contact with electrical wires.

f. Reduction in diameter. Reductions from nominal diameter of more than 3/64 inch for rope diameters up to and including 3/4 inch, of more than 1/16 inch for diameter 7/8 to 1-1/8 inches, and of more than 3/32 inch for rope diameters 1-1/4 to 1-1/2 inches.

17.3.11 ***Socket breaks.*** When two or more wires are broken or rust or corrosion is found adjacent to a socket or end fitting, the wire rope shall be resocketed or removed from service.

17.3.12 ***Marking defective rope.*** Wire rope removed from service due to defects shall be cut up and discarded, or plainly marked as being unfit for load bearing service.

17.3.13 ***Hazardous location.*** Running lines of stationary hoisting equipment located within 8 feet of the ground or working level shall be guarded, or the hazard area enclosed or barricaded.

17.4 SLINGS

17.4.1 ***Safe working load.*** The safe working loads of slings shall not exceed the rated capacities set forth in tables H-1 through H-18, 29 CFR 1926.251. (Refer to appendix BB, tables 1 through 18.) For types of slings not included in these referenced tables, the manufacturer's recommended safe working load for the specific angle of loading shall be followed, provided that a minimum safety factor of five is maintained.

17.4.2 ***Protection.*** Slings shall be protected from sharp, rough, or square corners by appropriate means in order to prevent damage to the strands, wires or links. Proper storage shall be provided for slings when not in use to ensure against damage that would impair their strength.

17.4.3 ***Removal from service.*** Chain, wire rope, fiber, synthetic webbing, metal mesh slings, and sling hooks shall be routinely inspected and removed from service when wear exceeds that set forth in appendix U, Removal of Slings From Service.

17.5 MANILA AND SYNTHETIC FIBER ROPE

17.5.1 ***Safe working load.*** The safe working loads for manila and synthetic fiber rope and slings shall not exceed the rated capacities as set forth in tables H-15 through H-18, 29 CFR 1926.2510. (Refer to appendix BB, tables 15 through 18.) When not specifically identified in the referenced tables, a minimum safety factor of five shall be used to compute the safe working load.

17.5.2 ***Splices.*** In addition to the manufacturer's recommendations, the following minimum requirements shall be met in splicing fiber rope.

a. Manila rope. Eye splices shall contain at least three full tucks, and short splices shall contain at least six full tucks with three on each side of the centerline of the splice.

b. Synthetic fiber. Eye splices shall contain at least four full tucks, and short splices at least eight full tucks with four on each side of the centerline of the splice.

c. Strand end tails. For fiber ropes under 1 inch in diameter, the tails shall project at least six rope diameters beyond the last full tuck. For ropes 1 inch and larger, the tails shall project at least 6 inches beyond the last full tuck. The required length of strand end tails may be tapered and spliced into the body of the rope using at least two additional tucks.

d. Eye of splice. The eye shall be sufficiently large to provide an angle of not greater than 60° at the splice when the eye is placed over the load or support.

e. Knots. Use of knots is prohibited.

17.5.3 ***Electrical hazard.*** Only nonconductive synthetic fiber rope shall be used in the proximity of energized conductors or equipment, including handlines for work on electrical facilities.

17.5.4 ***Care of fiber ropes.*** Proper care shall be given fiber ropes to maintain them in safe condition. Fiber ropes that have been subjected to acids, alkalies, freezing, or excessive heat shall not be used for load carrying purpose. Fiber rope shall be protected from abrasion by padding when it is drawn over square corners, or sharp or rough surfaces.

17.5.5 ***Synthetic webbing slings.*** Synthetic web slings shall be marked or coded to indicate manufacturer's name, type of material, and the rated capacity for the type of hitch.

17.6 SHACKLES AND HOOKS

17.6.1 *Shackles*

a. Safe working load. Table 17-2 shall be used to determine the safe working loads of shackles, except that higher safe working loads are permissible when recommended by the manufacturer for specific identifiable products; provided that a minimum safety factor of five is maintained.

b. Hoisting. Shackles used for hoisting shall be of forged alloy steel, and shall be of the locking or secured-pin type.

c. Wear or damage. Shackles that are bent, distorted, or worn in the crown or pin by more than 10 percent of their original diameter shall be removed from service.

Table 17-2.—*Safe working loads for shackles*

(2000-lb tons)

Material size	Pin diameter	Safe working load
1/2 inch	5/8 inch	1.4 tons
5/8 inch	3/4 inch	2.2 tons
3/4 inch	7/8 inch	3.2 tons
7/8 inch	1 inch	4.3 tons
1 inch	1-1/8 inches	5.6 tons
1-1/8 inches	1-1/4 inches	6.7 tons
1-1/4 inches	1-3/8 inches	8.2 tons
1-3/8 inches	1-1/2 inches	10.0 tons
1-1/2 inches	1-5/8 inches	11.9 tons
1-3/4 inches	2 inches	16.2 tons
2 inches	2-1/4 inches	21.2 tons

17.6.2 *Hooks*

a. Safe working load. The manufacturer's recommendation shall be followed in determining the safe working load for the specific size and type of hook used. Hooks for which no manufacturer's recommendation is available shall be tested at twice the intended safe working load prior to use. The contractor shall maintain a record of the dates and results of the tests.

b. Hoisting hooks. Hoisting hooks, as opposed to sling and choker hooks, shall be of forged alloy steel, and shall be stamped with their safeworking loads. Hoisting hooks should preferably be used with swivels and headache balls, and shall be equipped with safety keepers. (Refer to paragraph 18.1.15.)

Section 18
HOISTING EQUIPMENT, PILEDRIVERS, AND CONVEYORS

18.1 HOISTING EQUIPMENT - GENERAL REQUIREMENTS

18.1.1 ***Requirement.*** The contractor shall comply with the manufacturer's specifications and limitations applicable to the installation, operation, and maintenance of all cranes, derricks, cable ways, and other hoisting equipment. When not available, the hoisting system and equipment specifications, limitations, and rated load capacities shall be determined by a licensed professional engineer competent in the field, and such information shall be submitted to the Contracting Officer for approval prior to equipment acquisition and installation unless exempted by the Contracting Officer's authorized representative. Attachments used with cranes and hoisting equipment shall not exceed the capacity, rating, or scope recommended by the manufacturer or determined by a licensed professional engineer.

18.1.2 ***Posting.*** Rated load capacities, operating speeds, and special warnings or instructions shall be posted where clearly visible to the operators of the hoisting equipment. The load capacities and instructions shall be reviewed with and strictly adhered to by the operator of the equipment. Except for tests, hoisting equipment shall not be loaded in excess of posted maximum loads considering boom angle, outrigger support, and other limiting factors.

18.1.3 ***Modifications.*** Modifications or additions which affect the capacity or safe operation of the equipment or system shall not be made without the manufacturer's written approval or approval of a licensed professional engineer competent in the field. When such modifications are made, the equipment shall be subjected to another performance test and

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the posted load capacities changed to reflect the modification.

18.1.4 ***Performance testing.*** Prior to initial onsite operation, at 12-month intervals, and following major repairs or modification, power cranes, aerial lifts, derricks, cableways, and other hoists and hoisting systems shall satisfactorily complete a performance test in order to demonstrate the equipment's ability to safely handle and maneuver the rated loads. The tests shall be conducted on the jobsite in the presence of a Bureau representative and in the manner set forth below:

a. Power cranes (crawler, locomotive, truck, and wheel mounted). The performance test shall be carried out with outriggers set and with a test load weighing 110 percent of the rated capacity at selected boom radius when boom angle is between 30 and 60° above the horizontal. If the crane is going to travel under load on actual work, it shall also be tested under travel conditions. The test shall consist of raising, lowering, and braking the load; also, unless limited by the manufacturer's specifications, by rotating the test load through 360° at the specified boom angle or radius. Cranes used with jibs or boom tip extensions shall be tested using both the main boom and the jib with an appropriate test load in each case.

b. Derricks, tower cranes, cableways, and hoists. Derricks, gantry cranes, tower cranes, overhead cranes, cableways, and hoists shall be performance tested with a test load weighing 110 percent of the rated load. The crane shall be tested in raising, lowering, and braking the load, as well as through the limits of swing and travel for tower cranes, bridge cranes, and similar hoisting equipment. Cableways shall be thoroughly performance tested in at least three travel positions including both limits of travel.

c. Inspection and test record. Cranes and hoisting equipment shall be thoroughly inspected to determine if they meet the requirements of this section and those set forth in appendix V, Record of Inspection and Test - Cranes and Hoisting Equipment. The inspection shall not be conducted until the crane or hoisting equipment is determined to be in compliance with all requirements and in satisfactory working order. The record of inspection and performance test shall be submitted to the Contracting Officer's representative on the form shown in appendix V.

d. Permanent overhead cranes. Permanently installed gantry and overhead cranes, installed under Bureau contract, shall be tested in accordance with the conditions and requirements set forth in the contract specifications.

18.1.5 ***Daily inspection and maintenance.*** Hoisting equipment shall be inspected prior to use at the start of each shift by a competent person(s) to determine whether or not it is in safe operating condition. Any damage or deficiencies shall be corrected prior to use. Provision shall be made for routine lubrication and maintenance of all hoisting equipment.

18.1.6 ***Operators.*** Operators of cranes, cableways, and other hoisting equipment described in this section shall be examined and provided with a physician's certificate stating that they are physically qualified to safely operate the hoisting equipment to which they are assigned. At least once a year, they shall undergo a physical examination and obtain a physician's certificate of physical fitness. A copy of the certificate shall be maintained by the contractor, and available to the Contracting Officer's representative. Also, every newly hired operator of hoisting equipment described in this section shall be individually checked out by an experienced operator or supervisor to determine if he is capable of safely operating the equipment.

18.1.7 ***Operation.*** When hoisting equipment is in operation, the operator shall not be permitted to perform any other work nor shall he leave the operator's position while a load is suspended in the air.

18.1.8 ***Braking.*** A braking system capable of stopping, lowering, and holding a load of at least 110 percent of the rated capacity shall be provided on all hoisting equipment.

18.1.9 ***Load drums.*** Load drums on load-hoisting equipment shall be equipped with dogs, pawls, or other positive holding devices. At least two full wraps of line shall always be maintained on hoisting drums.

18.1.10 ***Riding loads.*** Except as provided in the following and in subsections 13.23 and 18.12, no person shall be permitted to ride loads, blocks, buckets, hooks, scaffolding, boatswain's chairs, cages, or other type devices attached to hoist lines or booms of any crane, derrick, or material hoist. The following exceptions are subject to prior approval of the Contracting Officer's representative: (1) Authorized designated personnel may ride in enclosed cages on approved-type manskips rigged to cableways or highlines; (2) Designated maintenance personnel may ride the carriage service platform of a cableway to perform inspection or maintenance operations.

18.1.11 ***Boom stops.*** Cranes or derricks with cable-supported booms, except draglines, shall have a device attached between the gantry of A-frame and boom chords to limit the elevation of the boom. The device shall control the vertical motions of the boom with gradually increasing resistance from 83° or less, until completely stopping the boom at not over 87° above the horizontal.

18.1.12 ***Hoisting ropes.*** Hoisting ropes shall be installed and maintained in accordance with the manufacturer's recommendations.

18.1.13 ***Safe clearance.*** Unless barricaded, adequate clearance shall be maintained between moving and rotating parts of a crane and other fixed objects in order to permit safe passage of persons.

18.1.14 ***Signal system.*** A uniform signal system, as set forth in subsection 9.5, shall be used in the operation of cranes, derricks, and hoists. Hand signals shall conform to those illustrated in appendix F, Hand Signals for Crane and Hoisting Equipment.

18.1.15 ***Safety hooks.*** Hooks used on hoisting equipment shall be equipped with approved safety keepers. Shackles used on slings or loads shall be of the locking type or pin secured.

18.1.16 ***High-voltage lines.*** Specific requirements pertaining to operation of cranes and other equipment near high-voltage lines are set forth in subsection 12.9

18.2 CRAWLER-, LOCOMOTIVE-, AND WHEEL-MOUNTED CRANES

18.2.1 ***Requirement.*** In addition to the requirements set forth in subsections 18.1 and 18.2, crawler-, locomotive-, truck-, and wheel-mounted cranes shall conform to the standards in the current edition of ANSI B30.5, "Safety Code for Crawler, Locomotive, and Truck Cranes." Sideboom cranes mounted on wheel or crawler tractors shall conform to the requirements in SAE J743a. Hydraulic cranes shall conform to the standards set forth in the current PCSA Standard No. 2, "Mobile Hydraulic Crane Standards."

18.2.2 ***Boom angle indicator.*** Crawler-, locomotive-, truck-, and wheel-mounted cranes shall be equipped with a boom angle or radius indicator located within the operator's view.

18.2.3 ***Level indicator.*** Means shall be provided for the operator to visually determine the levelness of the crane.

18.2.4 ***Jib stops.*** In addition to boom stops, jibs shall have a positive stop installed to prevent overtopping.

18.2.5 ***Cab windows.*** Windows installed in crane cabs shall be safety glass or equivalent that introduces no visibility distortion which will interfere with the safe operation of the crane.

18.2.6 ***Securing booms.*** When not in use, crane booms shall be lowered to the ground or otherwise secured to prevent displacement by wind or other outside forces.

18.2.7 ***Audible warning device.*** Power cranes shall be equipped with an audible warning signal device that can be heard above usual construction noise levels.

18.2.8 ***Taglines.*** Taglines for controlling loads shall be used whenever necessary for protection of personel.

18.2.9 ***Fire extinguisher.*** A fire extinguisher rated 5 B:C or greater shall be available in the cab.

18.3 TOWER CRANES

18.3.1 ***Requirement.*** In addition to the requirements set forth in subsections 18.1 and 18.3, tower cranes shall conform to the applicable standards in the current edition of ANSI B30.4, "Safety Standards for Portal, Tower, and Pillar Cranes."

18.3.2 ***Manufacturer's recommendations.*** Tower cranes shall be installed, tested, operated, and maintained in accordance with the manufacturer's recommendations.

18.3.3 ***Operating cab.*** The operator's cab of a tower crane, either tower mounted or remote from the tower, shall meet the following minimum requirements.

a. Vision. The cab shall be designed and constructed to provide the operator a clear and unrestricted view of the load and boom point and as clear a view of the jobsite as possible.

b. Windows. The windows shall be constructed of safety glass or equivalent and designed to provide ventilation.

c. Lock. The cab shall be equipped with a lock to prevent unauthorized entry unless the control unit can be separately locked.

d. Access. The cab shall be provided with a means of safe access for the operator. All walking surfaces to and from the cab shall be of an anti-slip type and protected with guard rails.

e. Wiper and defroster. The windshield shall be equipped with a windshield wiper and in cold climates, a heater and defroster installed in the cab.

f. Fire extinguisher. The cab shall be provided with at least a 4 B:C unit fire extinguisher.

18.3.4 ***Operating controls.*** All controls shall be deadman type that automatically return to neutral when released. Each control shall be plainly marked to indicate its function and in easy reach of the operator. The main switch shall be lockable and within reach of the operator.

18.3.5 ***Brakes.*** All brakes on the crane shall be designed so that the brake will be automatically applied when there is loss of power and cannot be released until power has been restored. The brake on the slewing drive shall be designed so that the jib will *weather-vane* when the wind pressure exceeds the pressure specified by the manufacturer.

18.3.6 ***Boom stops.*** Luffing boom tower cranes shall be equipped with a shock absorbing boom stop of a type which disengages the boom hoist motor and physically stops the boom at a predetermined maximum angle.

18.3.7 ***Limit switches.*** Tower cranes of every configuration shall be equipped with the limit switches described in the following:

a. A hook height limit switch that causes the hoist drum to stop whenever the load hook reaches a predetermined maximum height below the head block.

b. Trolley limit switches that stop the trolley motion whenever the trolley reaches a predetermined "out" or maximum "in" position.

c. An overload limit switch that causes the hoist drum to stop whenever the load being hoisted exceeds the maximum rated load for any radius or boom angle or whenever the overturning moment exceeds the rated load moment.

18.3.8 ***Boom angle indicator.*** A boom angle indicator shall be installed on all machines having booms capable of moving in the vertical plane.

18.3.9 ***Audible warning.*** Tower cranes shall have an audible warning device controlled by the operator.

18.3.10 ***Maintenance access.*** Safety lines with runners for attachment of safety belt lanyards shall be fitted to tower crane jibs and safety platforms shall be installed on the trolleys of saddle jibs to afford safe inspection and maintenance.

18.3.11 ***Trolley radius markers.*** Trolley radius markers clearly visible from the cab shall be installed on the jib.

18.3.12 ***Track-mounted tower cranes.*** Track-mounted tower cranes shall have limit switches and stops or buffers installed at each end of the tracks. The wheel tracks shall be equipped with rail sweeps extending below the top of the rail.

18.4 OVERHEAD AND GANTRY CRANES

18.4.1 ***Requirement.*** In addition to the requirements set forth in subsections 18.1 and 18.4, overhead and gantry cranes shall conform to the standards in the current edition of ANSI B30.2, "Safety Code for Overhead and Gantry Cranes."

18.4.2 ***Crane access.*** Access to the cab and/or bridge walkway shall be by a fixed ladder, stairs, or platform with no step over any gaps exceeding 12 inches. Fixed ladders and stairways shall be in compliance with the requirements set forth in section 14.

18.4.3 ***Platforms and walkways.*** Maintenance platforms and walkways protected by standard guardrails and toeboards, and means of safe access shall be installed on the trolley and bridge. Where it is impractical to install platforms and walkways, safety lines with runners for attachment of safety belt lanyards shall be installed to afford safe inspection and maintenance.

18.4.4. ***Limit switches and rail stops.*** Rail-mounted cranes, trolleys, and bridges shall be equipped with both switches and rail stops or buffers at each end of the tracks.

18.4.5 ***Rail sweeps.*** Track-mounted cranes, bridges, and trolleys shall be equipped with rail sweeps extending below the top of the rail and effective in all directions of travel.

18.4.6 ***Audible alarm.*** Except for floor-operated cranes, a gong or other effective audible warning signal shall be installed on cranes with power traveling mechanisms.

18.4.7 ***Hook limit switch.*** A hook height limit switch that causes the hoist drum to stop whenever the load hook reaches a predetermined maximum height below the headblock shall be installed on overhead and gantry cranes.

18.4.8 ***Operating controls.*** All controls shall be deadman type that automatically return to neutral when released. Each control shall be plainly marked to indicate its function. A main power switch capable of being locked in the open position shall be within reach of the operator.

18.4.9 ***Brakes.*** All brakes shall be designed so that the brake will be automatically applied when there is a loss of power and cannot be released until power has been restored.

18.4.10 ***Fire extinguisher.*** A fire extinguisher of 5 B:C rating or greater shall be mounted in the cab.

18.5 PEDESTAL-MOUNTED CRANES AND DERRICKS

18.5.1 ***Requirement.*** Pedestal-mounted cranes and derricks, in addition to the requirements set forth in subsections 18.1 and 18.5, shall conform to the standards in the current edition of ANSI B30.6, "Safety Code for Derricks."

18.5.2 ***Foundation.*** Pedestal-mounted cranes and derricks shall set on foundations designed and constructed to support the weight of the crane plus the maximum rated load with a safety factor of at least four (4).

18.5.3 ***Boom angle indicator.*** A boom angle or radius indicator shall be provided within the operator's view.

18.5.4 ***Fire extinguisher.*** A fire extinguisher of 5 B:C rating or greater shall be mounted at the operator's station.

18.6 FLOATING CRANES

18.6.1 ***Requirement.*** Floating cranes and derricks, in addition to the requirements set forth in subsections 18.1 and 18.6, shall conform to the standards in the current edition of ANSI B30.8, "Safety Code for Floating Cranes and Floating Derricks."

18.6.2 ***Performance test.*** The performance test shall demonstrate the strength, stability, and capability to safely support and maneuver 125 percent of the anticipated load.

18.6.3 ***Load rating chart.*** When load ratings are reduced to compensate for barge list, a new rating chart shall be provided. Barge-mounted cranes, designed and constructed as a unit, shall be rated by the manufacturer. All other barge-mounted cranes shall be of sufficient size to limit the list under maximum load to 5°.

18.6.4 ***Wave action.*** Crane operation shall be suspended when significant wave action exists.

18.6.5 ***Truck and crawler cranes.*** Truck and crawler cranes, when used as floating cranes, shall be securely attached to the barge. However, when the stability of the barge is not a factor, limited travel may be permitted providing positive travel stop logs or equivalent are provided and the operation is approved by the Contracting Officer's representative.

18.7 OVERHEAD HOISTS

18.7.1 ***Requirement.*** The installation, use, and maintenance of overhead hoists shall be in compliance with the manufacturer's recommendations and the requirements of this subsection.

18.7.2 ***Safe working load.*** The safe working load, as determined by the manufacturer, shall be indicated on the hoist and shall not be exceeded.

18.7.3 ***Support.*** The supporting structure shall have a safe working load exceeding that of the hoist plus the maximum rated loading with a safety factor of at least four. The support shall provide unobstructed movement of the hoist and load. It shall also permit the operator to stand clear of the load in all hoisting positions.

18.7.4 ***Limit switch.*** Power operated overhead hoists shall be equipped with a limit switch which will prevent the load hook from "two-blocking."

18.7.5 ***Emergency stop switch.*** In addition to the regular operating controls, power operated overhead hoists shall have a manually or automatically operated switch, within the operator's reach if manually operated, which will cut off the power supply in case of a malfunction.

18.7.6 ***Air operated hoists.*** Air hoists shall be connected to an air supply of sufficient capacity and working pressure to safely operate the hoist with maximum load.

18.7.7 ***Hand powered hoists.*** Hand powered hoists shall be gear driven-type, or equipped with a pawl or ratchet permitting effective control and braking reliability.

18.8 CABLEWAYS AND HIGHLINES

18.8.1 ***Requirement.*** In addition to the requirements of this subsection, cableways and highlines shall comply with the applicable installation, testing, operation, and maintenance requirements set forth in subsection 18.1.

18.8.2 ***Design and installation.*** Cableways and highlines shall be designed by licensed professional engineers qualified in the field, and installed and operated in accordance with the design drawings, specifications, and operating instructions furnished by the engineer. Following installation and prior to use, each cableway and highline shall be performance tested as set forth in subparagraph 18.1.4.b; such tests will be performed under the direct supervision of the design engineer.

18.8.3 ***Inspection and maintenance.*** A daily inspection shall be made of all cableway components and provision made for daily routine maintenance and lubrication.

18.8.4 ***Cableway log.*** A log shall be maintained for each cableway or highline in which inspections, lubrication, maintenance, and repair activity are recorded. The log shall also include operating time, downtime, and be signed by the employees responsible for performing the maintenance or repair work.

18.8.5 ***Signal system.*** At least two systems of communication and control shall be continuously maintained between the operator and the signalman. One or both of the systems shall provide voice communication by telephone or radio. Use of lights or bells may be substituted for one of the systems. When the dual system is not functioning properly, the operator shall lock out the cableway controls until both systems are repaired and functioning.

18.8.6 ***Control consoles.*** During operation of the cableway, only the operator(s) shall be permitted in the control console room. The console room windows shall be safety glass, or equivalent, that introduce no visibility distortion that interferes with the safe operation of the cableway. The room shall be heated and/or air conditioned as necessary for the operator's comfort.

18.8.7 ***Operating controls.*** All controls shall be deadman type that automatically return to neutral when released. Each control shall be plainly marked to indicate its function and in easy reach of the operator.

18.8.8 ***Cableway platforms and carriages.*** Cableway platforms, moving and stationary, shall be provided with standard guardrails and toeboards. Open areas on carriages and moving platforms shall be enclosed with wire mesh to reduce the hazard from falling objects.

18.8.9 ***Concrete buckets.*** Concrete buckets shall be designed with a safety device which will prevent accidental opening of the bucket while in transit to the discharge site. Buckets shall be constructed in a manner which prevents aggregate from lodging on any part of the bucket.

18.8.10 ***Riding cableways.*** Refer to paragraph 18.1.10.

18.8.11 ***Track-mounted towers.*** Track-mounted cableway towers or structures shall be equipped with both limit switches and rail stops or buffers at each end of the tracks. The wheel trucks shall be equipped with track or rail sweeps extending below the top of the rail and effective in all directions of travel. When two or more towers operate on the same track, an automatic control system shall be installed to prevent the towers from colliding.

18.9 ELEVATORS

18.9.1 ***Requirement.*** Whenever practical, depending on the nature and size of the job, permanent passenger and/or freight elevators should be installed and used. Permanent elevators shall be designed, constructed, tested, inspected, and maintained in accordance with the current editions of ANSI A17.1, "Safety Code for Elevators, Dumbwaiters, and Moving Walks;" and ANSI A17.2, "Practice for Inspection of Elevators." Following installation, elevators will be inspected and tested in accordance with referenced standards prior to use for construction purposes and once each year thereafter.

18.10 PERSONNEL HOISTS

18.10.1 ***Requirement.*** Personnel hoists shall be constructed, installed, tested, operated, and maintained as set forth in the current edition of ANSI A10.4, "Safety Requirements for Personnel Hoists," and the requirements of this subsection.

18.10.2 ***Design and installation.*** The contractor shall comply with the manufacturer's drawings, specifications, and limitations in the installation and operation of personnel hoists. All personnel hoists shall be designed by a licensed professional engineer competent in the field and fully cognizant of the applicable ANSI standards.

18.10.3 ***Posting.*** Rated load capacities, recommended operating speeds, and special hazard warnings shall be posted on cages, platforms, and at the operator's station.

18.10.4 ***Hoistway enclosure.*** Hoist towers installed outside buildings or structures shall be enclosed for the full height on the side or sides used for entrance or exit to the building or structure. The other sides shall be enclosed to a height of at least 10 feet at the lowest landing. Sides of the tower adjacent to floors or scaffold platforms shall be enclosed to a height of 10 feet above the level of such floors or scaffolds. Towers inside buildings or structures shall be enclosed on all four sides throughout the full height.

18.10.5 ***Tower anchorage.*** Towers shall be anchored to the structure at intervals not exceeding 25 feet. In addition to tie-ins, a series of guys shall be installed. Where tie-ins are not practical, the tower shall be anchored by wire rope guys at least 0.5 inch in diameter securely fastened to anchorages to ensure stability.

18.10.6 ***Cage enclosure.*** Cages shall be fully enclosed on all sides and the top, except sides used for entrance which shall have car gates or doors.

18.10.7 ***Entrance doors.*** A door or gate shall be provided at each entrance to the cage, designed to cover the full height and width of the cage entrance opening.

18.10.8 ***Door interlocks.*** Doors or gates shall be provided with interlocks which will not permit movement of the cage unless the door or gate is fully closed.

18.10.9 ***Overhead protection.*** Overhead protective covering of 2-inch planking, 0.75-inch plywood, or other equivalent strength material shall fully cover the top of the cage.

18.10.10 ***Overspeed safety device.*** The cage shall be equipped with an overspeed safety device which will stop and hold the cage plus the maximum rated load when the governor tripping speed is exceeded or the hoist rope fails.

18.10.11 ***Brakes.*** The hoist shall be equipped with two independent braking systems. One system shall be an automatic-type system that will be applied when the controls are in neutral or in event of a power failure. An equivalent system of gearing and/or braking affording equal protection is acceptable. In addition, a manually operated braking system shall be provided, attached to the hoist drum, and capable of stopping and holding at least 125 percent of the full rated load in any position.

18.10.12 ***Power-up and power-down.*** The hoist power unit shall be designed to provide power-up and power-down through the gears at all times. Also refer to paragraph 18.10.11.

18.10.13 ***Controls.*** On manually controlled hoists, the controls shall be the dead-man type which will return to the neutral or stop position when pressure is removed from the control lever.

18.10.14 ***Maximum speed.*** The speed of the cage shall not exceed 200 feet per minute.

18.10.15 ***Travel limit stops.*** Hoists shall be equipped with approved limit switches which will automatically cause the cage to stop at the top and bottom limits of travel.

18.10.16 ***Internal combustion engines.*** Internal combustion engines shall not be permitted for direct drive.

18.10.17 ***Hoist ropes.*** Hoist wire ropes shall meet the following minimum requirements:

a. Minimum number. Drum hoists shall have at least two hoisting ropes, and traction hoists shall have at least three hoisting ropes.

b. Safety factor. Hoisting and counterweight ropes shall have the following minimum safety factor, but in no event shall they be less than 0.5 inch in diameter:

Rope speed ft/min	Minimum safety factor
0-100	8.00
101-125	8.10
126-150	8.25
151-175	8.40
176-200	8.60

201-225	8.75
226-250	8.90
251-300	9.20
301-350	9.50
351-400	9.75
401-500	10.25
501-600	10.70

18.10.18 ***Emergency stop.*** An emergency stop switch shall be installed in the cage and marked **STOP.**

18.10.19 ***Maintenance access.*** Safe accessways shall be provided for inspection and maintenance of hoist towers and equipment.

18.10.20 ***Bridge tower construction.*** Personnel hoists used in bridge tower construction shall be designed by a licensed professional engineer and erected under the supervision of an engineer competent in the field. These hoists shall be inspected at least weekly and whenever exposed to winds exceeding 35 miles per hour.

18.10.21 ***Wire rope.*** Hoisting and counterweight rope shall be inspected daily and removed from service when any of the conditions described in paragraph 17.3.10 exist.

18.10.22 ***Signals.*** Personnel hoists operated by a hoisting engineer shall be controlled by a radio, telephone, or a visual and audible electrically operated signal system installed between the operator and each cage access point.

18.10.23. ***Performance testing.*** Following installation and prior to use, and at least once a year thereafter, each personnel hoist shall be inspected and tested by a competent person under the direction of a qualified supervisor or professional engineer. The tests shall be carried out under full rated loading and all safety devices shall be tested to determine if they are functioning properly.

18.11 MATERIAL HOISTS

18.11.1 ***Requirement.*** Material hoists shall be constructed, installed, tested, operated, and maintained as set forth in the latest edition of ANSI A10.5, "Safety Requirements for Material Hoists," and the requirements of this subsection.

18.11.2 ***Posting.*** Operating rules including signals, line speeds, loading, etc., shall be posted at the operator's station and on the cage frame or crosshead.

18.11.3 ***Riding.*** No person shall be permitted to ride a material hoist except for the purpose of inspection and maintenance. Each hoist cage or platform shall be conspicuously posted **NO RIDERS ALLOWED.**

18.11.4 ***Hoistway entrances.*** Entrances to the hoistway shall be protected by substantial gates or bars installed the full width of the landing entrance. Entrance bars and gates shall be painted with diagonal contrasting colors such as black and yellow stripes. Bars shall be not less than 2- by 4-inch wood, or equivalent, located not less than 36 inches nor more than 42 inches above the floor. They shall be located at least 2 feet from the hoist cable and equipped with a latching device.

18.11.5 ***Overhead protection.*** The top of the cage or platform shall be protected by 2-inch planking, 0.75-inch plywood, or material of equivalent strength.

18.11.6 ***Tower enclosures.*** Hoist towers may be or may not be enclosed on all sides. Whichever alternative is chosen, the following requirements shall apply.

a. Enclosed. When a hoistway or tower is enclosed, it shall be enclosed on all sides for its entire height with 0.5-inch wire mesh screen, No. 18 U.S. gage or equivalent, except at access points.

b. Open sides. When the hoist tower is not enclosed, the hoist cage or platform shall be totally enclosed on all sides between the floor and the protective top with 0.5-inch wire mesh screen, No. 14 U.S. gage or equivalent. The hoist cage or platform enclosure shall include the required gates for loading and unloading. An enclosure at least 6 feet high shall be installed on the unused sides of the hoist tower at ground level.

18.11.7 ***Operator's station.*** The operator's station shall be protected by overhead planking not less than 2 inches thick, or material of equivalent strength.

18.11.8 ***Towers and shaftways.*** Towers and shaftways shall be designed by a licensed professional engineer and shall have a maximum-loading safety factor of at least five.

18.11.9 ***Broken-cable safety device.*** Cars or platforms shall be equipped with a broken-cable safety device capable of stopping and holding the platform in event of a cable failure.

18.11.10 ***Tower support.*** Towers shall rest on solid foundations, be plumb and well guyed, or otherwise anchored in four directions at the top and at least every 30 feet in height.

18.11.11 ***Hinged roof.*** The car or platform roof may be hinged to accommodate long material.

18.11.12 ***Electric-motor-driven hoists.*** Electric-motor-driven hoists shall be provided with an electromechanical automatic motor brake or similar device to automatically stop and hold the load in case of a power failure.

18.11.13 ***Operating restriction.*** Not more than one cage, bucket, or hoist platform shall be operated at the same time by one hoisting machine or by one operator.

18.11.14 ***Hoisting machines.*** Hoisting machines shall be designed and installed to raise and lower the maximum rated load plus the weight of equipment and ropes and shall incorporate the following features.

a. Brakes. The brakes shall be capable of stopping and holding 125 percent of the rated hoisting capacity under all operating conditions.

b. Mechanical brakes. Mechanical brakes shall be installed to stop movement of the hoist drum and shall be equipped with a positive acting device that will hold the brake in the engaged position.

c. Ratchet and pawl. Friction-clutch-driven winding drum hoisting machines shall be equipped with an effective pawl and ratchet capable of holding the rated load capacity when it is suspended.

18.11.15 ***Position indicator.*** A positive system shall be used to indicate when the hoist car or platform has reached specific locations including the top and bottom landings.

18.11.16 ***Signal system***

a. Hand signals. Hand signals may be used on a single drum hoist when the hoist tower does not exceed 50 feet in height and the signals are clearly visible to the operator at all times.

b. Electrical communication. A closed-circuit electrical communication system shall be used on all other material hoist installations. The system shall be a two-way system with a speaker located at the hoist operator's station and at each landing. The hoist operator shall be able to communicate by voice to and from each station.

18.11.17 ***Fire extinguisher.*** A fire extinguisher of 5 B:C rating or greater shall be mounted at the operator's station.

18.11.18 ***Testing.*** Following installation and prior to use each material hoist shall be inspected and tested under full rated loading by a competent person under direction of a supervisor.

18.12 AERIAL LIFTS

18.12.1 ***Requirement.*** Aerial lifts shall be designed, constructed, and operated in conformance with the standards in the current edition of ANSI A92.2, "Vehicle Mounted Elevating and Rotating Work Platforms." They shall also conform to the requirements of this subsection and the applicable provisions of subsection 18.1, including provision for performance testing. Aerial lifts shall include the following types of vehicle mounted aerial devices for elevating personnel: (a) extendible boom platforms, (b) aerial ladders, (c) articulating boom platforms, (d) vertical towers, or (e) any combination of (abcd).

18.12.2 ***Modification.*** Aerial lifts may be modified for uses other than those intended by the manufacturer, provided the modification has been certified in writing by the manufacturer or by other qualified equivalent entity, such as a testing laboratory, to be in conformity with the applicable provisions of ANSI A92.2 and the requirements of this subsection.

18.12.3 ***Ladder trucks and tower trucks.*** Aerial ladders shall be secured in the lower traveling position by a locking device on top of the truck cab and by a manually operated device at the base of the ladder before the truck is permitted to travel.

18.12.4 ***Routine testing.*** Prior to use each shift, the boom shall be elevated and the aerial lift checked to ensure that all controls and safety devices are functioning properly.

18.12.5 ***Operators.*** In addition to meeting minimum physical qualifications set forth for crane operators in Chapter 5 of ANSI B30.5 (and paragraph 18.1.6 for operators engaged in barehand live line or energized work), operators shall be instructed and trained in the operation of the type of equipment to which they are assigned. Only persons specifically authorized to operate aerial lifts shall operate this type of equipment.

18.12.6 ***Body belts.*** Employees working from an aerial lift shall wear a body belt or safety belt and a lanyard attached to the basket, platform, or boom. They shall stand on the floor of the basket or platform and shall not sit or climb up on the guardrail or enclosure. Use of planks, ladders, or other devices for work platforms is prohibited.

18.12.7 ***Load limits.*** Load limits specified by the manufacturer shall be posted on the equipment and shall not be exceeded.

18.12.8 ***Wheel chocks and outriggers.*** Wheel chocks shall be used when operating an aerial lift on an incline. When outriggers are used, they shall be positioned on pads or a solid surface and brakes set.

18.12.9 ***Moving.*** Aerial lift trucks, except for equipment specifically designed for that purpose, shall not be moved when the boom is elevated with men in the basket or work platform.

18.12.10 ***Controls.*** Articulating boom and extensible boom platforms shall have both platform (upper) and lower controls. Upper controls shall be mounted on the basket or platform within easy reach of the operator. Lower controls shall be designed to override the upper controls. Controls shall be plainly marked as to their function.

18.12.11 ***Welds.*** All welds on aerial lift support members shall conform to the following standards and tests as applicable.

a. Welding Procedures and Performance Qualifications, American Welding Society (AWS) B3.0

b. Recommended Practices for Automotive Welding-Design, AWS D8.4-61.

c. Standard for Qualification of Welding Procedures and Welders Piping and Tubing, AWS D10.9-69

d. Structural Welding Code, AWS D1.1

e. Welds, the failure of which could result in dropping the boom or platform, shall be magnifluxed or dye penetration tested initially and at 2-year intervals thereafter.

18.12.12 ***Hydraulic and pneumatic systems.*** The provisions of ANSI A92.2, section 4.9, "Bursting Safety Factor," shall apply to all critical hydraulic and pneumatic components. Critical components are those in which a failure would result in a free fall or free rotation of the boom. All other components shall have a bursting safety factor of at least two.

18.12.13 *Insulated booms*

a. Testing and certification. Any aerial device or component thereof, which is represented by the manufacturer or installer as being insulated, shall be tested and certified as set forth in ANSI A92.2-1969, section 5, "Manufacturer's Electrical Tests on Insulated Devices."

b. Operation. The insulated aerial lift, when used to work on or near high-voltage lines or equipment, shall be tested, operated, and maintained in strict compliance with the manual or manuals provided by the manufacturer. The manual(s) shall contain:

(1) Description, specifications, and capacities of the aerial device

(2) Instructions for installing or mounting the device

(3) Operating pressures of any hydraulic or pneumatic system which is part of the aerial device

(4) Specific instructions regarding field testing, operation, and maintenance

(5) Replacement part information

(6) Manufacturer's Certification Test

c. Alteration. Insulated portions of the lift, basket, and boom shall not be altered in any manner that might reduce its insulating value.

18.13 HELICOPTER OPERATIONS

18.13.1 ***Federal Aviation Administration.*** Operators and aircraft shall be licensed and fully comply with the applicable regulations of the FAA.

18.13.2 ***Briefing.*** Prior to each day's operation, a briefing shall be conducted for pilots and ground personnel to discuss in detail the plan of operation.

18.13.3 ***Loads.*** Suspended loads shall be secured with pressed sleeve, swedged eyes, or equivalent means in order to prevent hand splices from spinning open or cable from loosening. Tag lines shall be of a length that will not permit their being drawn into the rotors.

18.13.4 ***Cargo hooks.*** Electrically operated cargo hooks shall have the electrical activating device so designed and installed to prevent accidental operation. These hooks shall also be equipped with an emergency mechanical control for releasing the load. The hooks shall be tested prior to each day's operation to ensure that they function properly.

18.13.5 ***Personal protective equipment.*** Employees receiving the load shall wear safety goggles and hard hats fitted with chin straps. Loose fitting clothing that may become snagged on the hoist line shall not be worn.

18.13.6 ***Downwash.*** Material and loose gear within 100 feet of the lift or delivery site shall be removed or secured.

18.13.7 ***Operator responsibility.*** The helicopter pilot shall be responsible for size, weight, and manner in which loads are connected to the helicopter. The lift shall not be made if he considers it unsafe.

18.13.8 ***Hooking and unhooking.*** Employees shall not perform work under the hovering helicopter except as necessary to hook and unhook loads. A safe means of access shall be provided for employees to approach the hook to engage or disengage cargo slings.

18.13.9 ***Static charge.*** Unless a grounding device is used to dissipate the static charge, ground personnel shall wear rubber gloves.

18.13.10 ***Weight limitation.*** The weight of the load and rigging shall not exceed the aircraft manufacturer's rating, considering altitude and ambient temperatures existing at the time.

18.13.11 ***Ground lines.*** Hoist wires or other gear, except for pulling lines or conductors which "pay-out" from a container or roll off a reel, shall not be attached to any fixed ground structure or allowed to foul on any fixed structure. Pulling lines or conductor stringing systems will be designed with stress release hardware so located it protects the aircraft against overload and line entanglement with rotors.

18.13.12 ***Visibility.*** When visibility is reduced by dust or other conditions, ground personnel shall exercise special caution to keep clear of the rotor blades. The contractor shall reduce the possibility of dust to the extent it is practical.

18.13.13 ***Approaching helicopters.*** Only designated authorized personnel shall be permitted to approach within 50 feet of a helicopter with the rotor blades turning. When approaching or leaving a helicopter with the blades turning, persons shall keep within full view of the pilot and assume a crouched position. Persons shall stay out of the area from the cockpit or cabin rearward unless authorized by the pilot to enter that area.

18.13.14 ***Radio communication.*** Provision shall be made for reliable radio communication between the pilot and a designated number of the ground crew during all loading, unloading, and rigging operations.

18.13.15 ***Hand signals.*** When hand signals are used, they shall be as illustrated in appendix W, Helicopter Hand Signals. The signalman on the ground shall be distinctly recognizable from other ground personnel.

18.13.16 ***Inspection and maintenance.*** Only FAA-certified personnel, experienced on type of aircraft being maintained, will be assigned to inspect or repair helicopters. Maintenance personnel shall be provided with lighting systems meeting minimum requirements set forth in subparagraph 7.11.6. During inclement weather, repair work will be carried out in enclosures adequate to protect personnel against the elements. All repairs pertaining to safety of flight shall be flight-tested by an appropriate pilot prior to aircraft being returned to service.

18.14 PILEDRIVERS

18.14.1 ***Hoisting equipment.*** Cranes used to drive or extract piling shall conform to the requirements and standards set forth in applicable parts of this section.

18.14.2 ***Floating piledrivers.*** The width of hulls for floating piledrivers shall not be less than 45 percent of the height of the lead above water. The operating deck shall be protected to prevent suspended piling from swinging or drifting in over the deck.

18.14.3 ***Hoist drums.*** Piledriver hoist drums shall not be equipped with dogs that automatically disengage by relieving the load or by rotating the drum.

18.14.4 ***Hose connections.*** Hose connections to piledriver hammers, ejectors, or jet pipes shall be secured with at least a 0.25-inch chain having a minimum working load of 3,250 pounds, or equivalent devices.

18.14.5 ***Driving leads.*** Hanging or swinging leads shall have fixed ladders for access. Fixed leads shall be provided with rings or attachment points for attaching safety belt lanyards. When fixed leads are provided with loft platforms, the platform shall be protected with standard guardrails. Employees shall use safety belts when working on the leads and shall not remain on the leads or ladders when piling is being driven.

18.14.6 ***Landings and headblocks.*** Fixed ladders or stairways shall be installed for access to landings and headblocks. Piledriver leads shall be provided with stopblocks to prevent the hammer from being raised into the headblock.

18.14.7 ***Blocking device.*** When employees are required to work under the hammer, a blocking device capable of supporting the hammer shall be placed in the leads.

18.14.8 ***Guying.*** Adequate guylines, outriggers, thrustouts, counterbalances, and/or rail clamps shall be used to stabilize piledrivers during operation.

18.14.9 ***Moving piledrivers.*** When the piledriver is being moved, the hammer shall be lowered to the bottom of the leads.

18.14.10 ***Hoisting piling.*** Piling shall be hoisted by means of a closed shackle or similar positive means of attachment to the loadline, and employees shall be kept in the clear. Taglines shall be used to control unguided piles and "flying hammers."

18.14.11 ***Pulling pile.*** Extractors shall be used to pull piling that cannot be pulled without exceeding the safe load rating of the pulling rig. When pulling piling, the crane boom shall not be elevated over 60° from the horizontal.

18.14.12 ***Overhead protection.*** Overhead protection, equivalent to 2-inch planking, shall be positioned so as not to interfere with the operator's view.

18.14.13 ***Headblock guards.*** Guards shall be installed to prevent the line from jumping out of the headblock.

18.14.14 ***Steam line controls.*** Steam line controls shall consist of two shutoff valves. One of the valves shall be a quick-acting lever-activated type within reach of the hammer operator.

18.14.15 ***Boilers and pressure vessels.*** Boilers and pressure vessels used in piledriving operations shall conform to the requirements and standards set forth in section 20, Boilers, Compressors, and Gas Cylinders.

18.14.16 ***Jacked piles.*** When driving jacked piles, excavation for access pits shall conform to the requirements of section 22, Excavation Operations. Access ladders shall be provided and bulkhead curbs erected to prevent material from falling into the excavation.

18.14.17 ***Cutting piling.*** Cutting or trimming the tops of driven piling shall not be performed within a distance less than twice that of the longest pile from the driving rig.

18.15 CONVEYORS AND RELATED EQUIPMENT

18.15.1 ***Requirement.*** The design, installation, operation, and maintenance of conveyors and related equipment shall conform to the standards in the current edition of ANSI B20.1, "Safety Standards for Conveyors and Related Equipment," and the requirements of this subsection.

18.15.2 ***Safe access.*** Accessways shall be provided to enable employees to safely lubricate, repair, and maintain the conveyors. Stairways, ladders, catwalks, and/or work platforms shall be provided to all areas requiring routine lubrication and maintenance; such areas shall include elevated head pulleys, tail pulleys, and drive stations on belt conveyors. Unless rollers on a belt conveyor are self-lubricating or remotely lubricated, a walkway protected with a standard guardrail and toeboards shall be erected for access to all elevated sections of the conveyor system.

18.15.3 ***Start-up signal.*** Conveyor systems shall be equipped with a time-delay audible warning system which will automatically sound an alarm before startup.

18.15.4 ***Anti-runaway device.*** On conveyors where reversing or runaway is a possibility, anti-runaway or "backup" stops shall be installed.

18.15.5 ***Start and stop switches.*** Start and stop switches, capable of starting and stopping the drive motor(s) shall be provided at the operator's station. Stop switches shall be installed at each motor or engine location.

18.15.6 ***Emergency stopping.*** Whenever access facilities such as walkways and work platforms are installed along or adjacent to unguarded moving parts of a conveyor presenting a hazard to employees, an emergency stop system shall be installed in these areas. The system shall consist of a line running along the entire length of the exposed section of conveyor and attached to a power disconnect switch which, when pulled, will stop the conveyor. The system shall be designed so the conveyor cannot be restarted until the switch or disconnect has been manually reset.

18.15.7 ***Spillage.*** Conveyors shall be designed and installed with sideboards or other provision to eliminate spillage or dislodgement of materials.

18.15.8 ***Elevated crossings.*** Where conveyors pass adjacent to or over work areas, accessways, roadways, railways, etc., suitable and effective protection shall be installed. The overhead protection shall be capable of catching and retaining any material that may fall from the conveyor.

18.15.9 ***Crossovers and underpasses.*** Crossovers or underpasses, adequately protected, shall be provided for passage over or under conveyors.

18.15.10 ***Hazardous locations.*** Whenever conveyors are installed in tunnels, shafts, pits, and similar confined areas, ample room shall be provided to permit safe access. Where this is not possible, the conveyor shall be completely enclosed. Unless enclosed, emergency stop systems as set forth in paragraph 18.15.6 shall be installed. Such areas shall be provided with adequate lighting.

18.15.11 ***Stockpiled materials.*** Conveyor tunnels under stockpiled bulk materials such as sand and gravel shall be open at both ends.

18.15.12 ***Hoppers, chutes, and bins.*** Openings to hoppers, bins, chutes, or other hazard areas shall be guarded or protected to prevent employees from stepping or falling into them.

18.15.13 ***Riding prohibited.*** Riding material conveyors is prohibited and **DANGER - NO RIDING** signs shall be posted along the conveyor.

18.15.14 ***Tag and lockout.*** Conveyors, feeds, screens, and other moving parts shall be locked out or otherwise rendered inoperable, and tagged with a **DO NOT OPERATE** tag during repair or hazardous maintenance work.

Section 19
MOTOR VEHICLES AND MECHANIZED EQUIPMENT

19.1 ROADS

19.1.1 ***Requirements.*** All roads on the construction site, including haul roads, shall be constructed to widths suitable for the safe operation of the vehicles and equipment at speeds proposed by the contractor and approved by the Contracting Officer's representative. All curves shall have open-sight line and as great a radius as practical. Maximum allowable grades shall be 12 percent, except where written permission is obtained from the Contracting Officer's representative to exceed this limit for specific operations. No vehicle or mechanized equipment shall be moved upon any haul road, accessway, or grade unless the roadway and grade are constructed to safely accommodate the movement of the vehicles and equipment involved.

19.1.2 ***Approval.*** The design of haul roads shall be submitted for approval of the Contracting Officer's representative prior to road construction.

19.1.3 ***Embankment protection.*** When a difference in road or working level exists, berms, curbs, or barricades shall be constructed to prevent the vehicles or equipment from overrunning the edge or the end of the embankment.

19.1.4 ***Drainage.*** Roadways shall be constructed with a slight crown and ditches provided to facilitate drainage.

19.1.5 ***Posting speed limits.*** All roads, including haul roads, shall be posted with curve signs and maximum speed limits as approved by the Contracting Officer's representative. Vehicle speeds shall be limited on curves and posted to speeds that will permit the vehicle to be stopped within one-half the minimum sight distance.

19.1.6 ***Single-lane haul roads.*** Single-lane haul roads with two-way traffic shall be provided with adequate turnouts. When turnouts are not practical, a traffic control system shall be provided to prevent accidents. Single-lane haul roads with two-way traffic shall only be used with prior written approval of the Contracting Officer's representative.

19.1.7 ***Two-way haul roads.*** Whenever possible, a right-hand traffic pattern shall be used on two-way haul roads. Any deviation from right-hand traffic patterns must be approved by the Contracting Officer's representative and signs and traffic control devices installed to safely control travel under these circumstances.

19.1.8 ***Traffic control devices.*** The contractor shall install traffic control devices including signal lights, signs, barricades, and/or flagmen necessary to ensure the safe movement of traffic. Refer to subsections 9.6 and 9.7 relating to traffic control signals and flagmen.

19.1.9 ***Road maintenance.*** All roadways, including haul roads, shall be routinely maintained in safe condition including the elimination or control of dust, ice, and similar hazards. Whenever dust conditions exist, adequate dust-laying equipment shall be available on the jobsite and shall be utilized to control the dust hazard.

19.2 OPERATING RULES - MOBILE EQUIPMENT

19.2.1 ***Requirement.*** The operating rules set forth in this subsection shall apply to all vehicles and mobile mechanized equipment used to perform the work under the contract.

Use of equipment in unusual configurations (i.e., yo-yo operations of dozers or other earthmoving equipment, hoisting with backhoe, anchoring of mobile equipment for use on slopes) will require manufacturer's written confirmation and approval or certification by a professional engineer competent in the field, development of a standard operating procedure, and prior approval of the Contracting Officer's representative.

19.2.2 ***Qualifications.*** Vehicles and mobile equipment shall be operated only by authorized employees who are qualified to operate the equipment to which they are assigned.

19.2.3 ***Speeds.*** Vehicles and mobile equipment shall not be operated at speeds greater than are reasonable and safe considering weather conditions, traffic, road conditions, type and conditions of equipment, etc. The operator must have the equipment under control at all times and be able to stop it within the clear-sight distance.

19.2.4 ***Gears engaged.*** No vehicle shall be operated on a downgrade with the gears in neutral or with the clutch disengaged.

19.2.5 ***Parking.*** No vehicle or equipment shall be stopped, parked, or left standing on any road or in any location in such a manner to endanger personnel or property. Vehicles and equipment shall not be left unattended unless the motor has been shut off, brakes securely set, and the gears engaged. When parked on a hill or grade, the wheels shall be turned into the curb or the wheels chocked.

19.2.6 ***Towing.*** Employees shall not be permitted between a towed and towing vehicle except when hooking or unhooking.

19.2.7 ***Unattended at night.*** Equipment left unattended at night on or near a roadway or in areas where work is in progress shall have lights, reflectors, or lighted or reflective barricades to identify the location of the equipment.

19.2.8 ***Unauthorized riding.*** Except for standup operation, vehicles and mobile equipment shall be equipped with seats for the operator and passengers. Unauthorized personnel shall be prohibited from riding in or upon vehicles and mobile equipment.

19.2.9 ***Hours of work.*** Operators of vehicles and mobile equipment shall not work over 12 continuous hours; following which, they must have at least 8 hours away from the job.

19.3 MAINTENANCE

19.3.1 ***Requirement.*** Prior to initial use, machinery and mechanized equipment shall be inspected and tested by qualified personnel to determine if it is in safe operating condition. The contractor shall initiate and carry out a scheduled maintenance program for vehicles and mechanized equipment, using competent mechanics or technicians. Where there is evidence of poor or inadequate maintenance, the Contracting Officer's representative may require certified reports indicating the date and type of maintenance performed on designated vehicles or equipment.

19.3.2 ***Inspection.*** Vehicles and mobile mechanized equipment in use shall be inspected at the beginning of each shift to ensure that the following equipment and accessories are in safe operating condition: service brakes including trailer brake connections, parking brakes, tires, horn, steering mechanism, operating controls, restraint systems, and safety devices. This inspection shall also include lights, reflectors, windshield wipers, defrosters, windshields, and coupling devices when such equipment is installed and used. All defects shall be corrected prior to putting the vehicle or equipment into service.

19.3.3 ***Removal from service.*** Vehicles or equipment found to be in unsafe operating condition shall be immediately removed from service until repaired and reinspected prior to being placed into service again.

19.3.4 ***Repair shutdown.*** Vehicles and equipment shall be shut down while repairs or adjustments are being made unless operation of the equipment is required in making the repairs or adjustments.

19.3.5 ***Refueling.*** Refueling shall be subject to the requirements set forth in paragraph 11.12.11.

19.3.6 ***Tire repair.*** A safety tire rack, cage, or equivalent protection shall be provided and used when inflating, mounting, or dismounting tires installed on split rims or rims equipped with locking rings or similar devices.

19.3.7 ***Blocking.*** Vehicles, heavy machinery, equipment, or parts thereof which are suspended or held aloft by use of slings, ropes, hoists, or jacks shall be blocked or cribbed to prevent falling or shifting prior to permitting employees to work under or between them. Dozer and scraper blades, end-loader buckets, dump bodies, and similar equipment shall be fully lowered or blocked when not in use and when being repaired.

19.4 MOTOR VEHICLES

19.4.1 ***Definition.*** The term motor vehicle as used in this subsection and referred to as a vehicle shall refer to any vehicle propelled by a self-contained power unit and vehicles towed by a vehicle having a self-contained power unit, with exception of vehicles operating on rails.

19.4.2 ***Lights.*** All vehicles or combination of vehicles shall have the following lights: Two head lights, one on each side, and at least one red tail-light on each side, which shall be operated between sunset and sunrise; one red or amber stoplight on each side; directional signal lights on each side both front and rear.

Exceptions: Off-highway earthmoving equipment (1) manufactured without such devices, (2) operated on roads inaccessible to the public, and (3) operated during daylight hours, and vision is not otherwise obscured, are exempt from these requirements. Compactors, rollers, and crawler-type units manufactured without such devices are exempt from taillight, directional signal, and stoplight requirements, and headlights only if operated during daylight hours.

19.4.3, 4, 5 ***Cabs, Mirrors, Horn.*** Vehicles with cabs shall be equipped with, safety glass windshields, heaters, and defrosting devices. Vehicles such as passenger cars and trucks shall be equipped with rearview mirrors. Vehicles shall be equipped with a horn or audible warning device operated from the operator's station.

19.4.6 ***Braking system.*** All vehicles, except trailers having a gross weight of 5,000 pounds or less, shall be equipped with operable service brakes and hand-operated parking brakes. The braking systems on every combination of vehicles shall be so designed as to be in approximate synchronization on all wheels and developing the required braking effort on the rearmost wheels first. The design shall provide for application of the brakes by the operator. Service and parking brakes shall be adequate to stop and to hold the vehicle under all conditions of service. Earthmoving and construction equipment require special factory-designed braking systems as set forth in subsection !9.6.

19.4.7 ***Cab protection.*** Haulage vehicles not equipped with covered rollover protective structures (ROPS) which are loaded by means of cranes, power shovels, loaders, or similar equipment shall have a cab shield and/or a protective steel canopy adequate to protect the operator from falling or shifting materials. When such protection is not installed, the operator shall leave the cab when the vehicle is being loaded or unloaded. However, this exception does not apply to off-highway earthmoving equipment. (See paragraph 19.6.3 "Rollover protective structures").

19.4.8 ***Securing loads.*** The load on every vehicle shall be properly distributed, chocked, tied down, or otherwise secured. Tools and materials transported in the same compartment as personnel shall be secured to prevent movement.

19.4.9 ***Towing devices.*** Towing devices used on any combination of vehicles shall be structurally adequate for the load imposed, and securely and properly mounted. A locking device shall be provided on fifth-wheel and tow-bar systems which will prevent accidental separation of the vehicles. Safety chains shall also be installed.

19.4.10 ***Dump trucks.*** Dump trucks shall be equipped with the following safety devices.

a. Trip handles. Trip handles or dump-body operating levers which control hoisting or dumping shall be equipped with a latch or similar device which will prevent accidental starting or tripping of the mechanism. The trip handle shall be located so that the operator is in the clear.

b. Holding device. Dump trucks shall be equipped with a manually operated device, permanently attached, which will prevent accidental lowering of the dump body or bed during inspection and/or maintenance.

19.4.11 ***Emergency equipment.*** When operated on public roads, trucks and combinations of vehicles with a carrying capacity of 2 tons or greater, and buses, shall be equipped with at least the following emergency equipment.

a. Flags and reflectors. One red flag not less than 12 inches square and three reflective markers to be used in event of emergency stops.

b. Wheel chocks. Two wheel chocks for each vehicle or each unit of a combination of vehicles.

c. Fire extinguishers. One 10 B:C dry chemical extinguisher. When transporting flammable cargo, at least two 10 B:C dry chemical, or equivalent, fire extinguishers are required.

19.4.12 ***Exhaust fumes.*** Exhaust fumes of all vehicles shall be controlled so that they present no hazard to the operator or passengers.

19.4.13 ***Fenders.*** All rubber-tired motor vehicles shall be equipped with fenders. Haul trucks operating on gravel-surfaced roads shall also be equipped with mud flaps. Refer to paragraph 19.6.6 covering fender requirements on off-highway vehicles.

19.4.14 ***Seatbelts.*** Seatbelts and anchorages meeting the requirements of 49 CFR, Part 571, Department of Transportation, Federal Motor Vehicle Safety Standards, shall be installed in all motor vehicles. Seatbelt requirements for off-highway vehicles are set forth in paragraph 19.6.2. Where seatbelts are installed, their use is mandatory.

19.5 MAN-HAUL VEHICLES AND BUSES

19.5.1 ***Requirement.*** In addition to the requirements set forth in subsections 19.2, 19.3, and 19.4, man-haul vehicles and buses shall conform to the requirements of this subsection.

19.5.2 ***Operator qualifications.*** Operators of man-haul vehicles and buses shall be 21 years of age or older and have in their possession valid state operator's permits or licenses for the type of vehicle being operated. The operator must have passed a physical examination within the past year showing him physically qualified to operate the vehicle safely.

19.5.3 ***Number of passengers.*** The number of passengers shall not exceed the number of seats provided.

19.5.4 ***Starting.*** Vehicles transporting personnel shall not be moved until the operator has checked that all persons are seated and the required guardrails, endgates, and/or doors are in place and closed.

19.5.5 ***Man-haul trucks.*** Trucks used to transport personnel shall be equipped with seats securely anchored, a rear endgate, and side enclosures. Steps or ladders for mounting and dismounting shall be provided.

19.5.6 ***Dump trucks.*** Bodies of dump trucks shall be made fast to the chassis when used to transport personnel. They shall be secured by a chain or equivalent means in addition to the regular locking device.

19.5.7 ***Tools and materials.*** Tools and materials shall be placed in containers or secured when transported in vehicles carrying personnel.

19.5.8 ***Riding.*** Passengers shall not be permitted to ride in a standing position or with any part of their body outside of the truck body. Riding on fenders, outside of the cab or truck body, or on the load is prohibited.

19.5.9 ***Moving vehicles.*** Employees shall not be permitted to get on or off any vehicle when it is in motion.

19.6 WHEEL-AND CRAWLER-MOUNTED EARTH-MOVING EQUIPMENT

19.6.1 ***Requirement.*** The requirements set forth in this subsection, together with those in subsections 19.2, 19.3, and 19.4, shall apply to crawler and rubber-tired tractors such as dozers, push-and-pull tractors, winch tractors, and mowers; off-highway, self-propelled, pneumatic-tired earthmovers, including scrapers and dump trucks of every description; motor graders, loaders, backhoes, rollers, compactors, and water trucks. These requirements shall also apply to agricultural- and industrial-type tractors and similar equipment.

19.6.2 ***Seatbelts.*** Seatbelts shall be installed in all equipment described in paragraph 19.6.1, except for equipment designed only for standup operation or off-highway earthmoving equipment not equipped with rollover protective structures (ROPS). Seatbelts shall meet the design and installation standards set forth in SAE J306a, "Seatbelts for Construction Equipment," or SAE J333b, "Operator Protection for Agricultural and Light Industrial Tractors," as applicable. Where seatbelts are installed, their use is mandatory.

19.6.3 ***Rollover protective structures (ROPS).*** Rollover protective structures shall be installed on all equipment described in paragraph 19.6.1 with the exception of crane-mounted-type backhoes; rollers and compactors less than 5,950 pounds; self-propelled rubber-tired tractors under 20 drawbar horsepower; steel rollers used exclusively for paving operations; and trucks designed exclusively for operation on public highways or manufactured with a cab shield and/or a protective steel canopy adequate to protect the operator from falling or shifting materials. ROPS shall meet the following design or performance criteria, and installation shall be in accordance with the manufacturer's or designer's recommendations.

a. The contractor shall furnish the Contracting Officer's representative a certification from the manufacturer or a licensed professional structural engineer attesting that the ROPS complies with SAE J397a, "Deflection Limiting Volume for Laboratory Evaluation of Rollover Protective Structures (ROPS) and Falling Object Protection Structures (FOPS) of Construction and Industrial Vehicles," and the applicable design or performance criteria listed in following subparagraphs b, c, and d. The following data permanently affixed to the ROPS shall be accepted in lieu of the certification: (1) manufacturer's or fabricator's name and address; (2) ROPS model number, if any; and (3) machine make, model, or series number for which the structure is designed.

b. The ROPS for construction and earthmoving equipment shall comply with SAE J1040a, "Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines," or with SAE standards superseding this standard.

c. The ROPS for light industrial or agriculture type tractors shall comply with the following applicable SAE standards or with superseding standards:

1. SAE J167a, "Overhead Protection for Agricultural Tractors - Test Procedures and Performance Requirements"
2. SAE J334b, "Protective Frame for Agricultural Tractors - Test Procedures and Performance Requirements"

d. The ROPS shall be acceptable if they meet the rollover protective structure criteria of the State of California.

e. The ROPS shall be acceptable if the contractor furnishes certifications from the manufacturer or a licensed professional structural engineer that the structure and supporting attachments will:

1. Show satisfactory performance by actual test of a prototype involving a minimum 360° roll,
2. Support not less than two times the weight of the prime mover based on the integrated loading of the supporting members with the resultant load applied at the point of impact, or
3. Support the following separately applied minimum loads:

   (a) One hundred twenty-five percent of the weight of the vehicle applied as a uniformly distributed horizontal load at the top of the ROPS and perpendicular to a vertical plane through the longitudinal axis of the prime mover, and

   (b) A load of twice the weight of the vehicle applied as a uniformly distributed horizontal load at the top of the ROPS after complying with (a).

f. Materials. Steel used in ROPS must have the capability to perform at 0 °F or exhibit Charpy V-notch impact strength of 8 foot-pounds at -20 °F with a standard Charpy V-notch, type A specimen and provide 20 percent elongation over 2 inches in a standard 2-inch gage length on a 0.505-inch-diameter tensile specimen. Bolts and nuts shall be SAE Grade 8 (reference SAE J429h and J995c).

g. Field welding. Field welding on ROPS shall be performed only by welders who are certified by the contractor as being qualified in accordance with the American Welding Society Standards B3.0, Part II, or equivalent.

19.6.4 ***Braking systems.*** All mobile equipment described in paragraph 19.6.1 shall have a service brake system, a parking brake system, and an emergency stopping system, all capable of stopping and holding the equipment fully loaded on the grade of operation for the specific piece of equipment. However, backhoes, rollers, compactors, agricultural and industrial tractors, and crawler-type equipment, do not require emergency stopping systems. The braking systems shall meet the minimum design and performance requirements set forth in this paragraph.

a. General. - The service brake system, parking brake system, and emergency stopping system on equipment manufactured after January 1, 1972, shall meet the performance criteria set forth in the following applicable SAE standards:

SAE J1026, "Minimum Performance Criteria for Braking Systems for Crawler Tractors and Crawler Loaders"

SAE J1152, "Minimum Performance Criteria for Braking Systems for Off-Highway, Rubber-Tired, Self-Propelled Construction Machines"

SAE J1136, "Minimum Performance Criteria for Braking Systems for Self-Propelled, Smooth Steel Wheel, Pneumatic-Tired or Multiple Projection Steel Wheel Rollers and Compactors"

SAE J1041, "Brake Test Procedure and Brake Performance Criteria for Agricultural Equipment"

The SAE standard practices relating to performance criteria for braking systems which were superseded by the above standards shall be acceptable if applicable to the specific model of equipment.

b. Service brake. Service braking systems on off-highway, rubber-tired, self-propelled equipment shall have a system recovery capability meeting the criteria set forth in SAE J1152. Service braking systems using stored energy shall be equipped with a warning device which actuates before system energy drops below 50 percent of the manufacturer's specified maximum operating energy level. The device shall be readily visible and/or audible to the operator and provide a continuous warning. Gages indicating pressure or vacuum shall not be acceptable as meeting this requirement.

c. Parking brake. All equipment shall be equipped with a parking brake system capable of being applied by a person seated in the operator's seat.

On off-highway, rubber-tired, self-propelled equipment, the system shall have the capability equivalent to holding the equipment, fully loaded, on a 15 percent dry-swept concrete grade, both in forward and reverse directions.

d. Emergency stopping system. The emergency stopping system shall be capable of being applied by the operator from the operator's seat. The system shall be arranged so that it cannot be released from the operator's seat after any application unless immediate reapplication can be made from the operator's seat to stop the equipment. If an automatic emergency stopping system is used, the automatic application shall occur after the warning device is actuated.

19.6.5 ***Brake performance test.*** The contractor shall conduct a brake performance test on all off-highway, self-propelled, pneumatic-tired earthmovers including scrapers and dump trucks of every description, prior to initial operation on the jobsite. The performance test shall include all three braking systems and shall be conducted in accordance with the criteria set forth on Reclamation form entitled, "Brake Performance Test Record," shown in appendix X. The tests shall be carried out by the contractor in the presence of a Bureau representative, and the test record submitted to the Contracting Officer's representative on the referenced form. Braking systems failing to approximate the performance criteria published in the appropriate SAE standard and reproduced on the form, shall be repaired or the equipment removed from service. Subsequent performance tests may be requested by the Contracting Officer's representative for designated equipment.

19.6.6 ***Fenders.*** Pneumatic-tired earthmoving haulage equipment including trucks, scrapers, tractors, and trailing units, whose maximum speed exceeds 15 mi/h, shall be equipped with fenders meeting the criteria set forth in SAE J321a, "Fenders for Pneumatic-Tired Earthmoving Haulage Equipment."

19.6.7 ***Scissor points.*** Scissor points on front-end loaders, which constitute a hazard to the operator during normal operations, shall be guarded.

19.6.8 ***Audible alarms***

a. Horn. All mobile equipment including rollers, compactors, loaders, scrapers, dozers, etc., shall be equipped with a horn, distinguishable from the surrounding noise level, which shall be operated as needed when the machine is moving in either direction.

b. Reverse signal alarm. No bidirectional earthmoving or compacting equipment which has an obstructed view to the rear shall be operated in reverse gear unless equipped with an automatic reverse signal alarm or a signalman is used to assist the operator. Audible reverse alarms shall be sufficiently distinct to be heard and distinguishable from the surrounding noise level. The alarm shall operate upon commencement of reverse motion and may be continuous or intermittent, not to exceed 3-second intervals. It shall operate during the entire reverse motion.

19.6.9 ***Clearing operations.*** In addition to ROPS; dozers, tractors, and similar equipment used in clearing operations shall be equipped with a substantial guard or canopy and grill to protect the operator. The guard or canopy shall be at least 1/8-inch steel plate or 1/4-inch woven wire mesh with openings no larger than 1 inch. The rear opening shall be protected with 1/4-inch wire mesh and maximum 1-inch openings or equivalent.

19.7 INDUSTRIAL TRUCKS

19.7.1 ***Requirement.*** All industrial trucks shall meet the requirements for design, construction, stability, inspection, testing, maintenance, and operation as set forth in ANSI B56.1, "Safety Standards for Powered Industrial Trucks, Low Lift and High Lift Trucks." High-lift rider trucks shall be equipped with overhead guards as described in ANSI B65.1.

19.7.2 ***Lift trucks and stackers.*** Lift trucks, stackers, etc., shall have capacity plates posted on the equipment in the operator's view. When removable counterweights are used, the corresponding rated capacities shall be indicated on the plates. Rated load capacities shall not be exceeded by the operator. No modifications or additions affecting the capacity or safe operation of the equipment shall be made without the manufacturer's written approval and the capacity plates correspondingly revised.

19.7.3 ***Multiple lifting.*** When a load is lifted by two or more trucks working in unison, the proportion of the total load being lifted by any one truck shall not exceed its capacity.

19.7.4 ***Steering knobs.*** Steering or spinner knobs shall not be attached to the steering wheel unless the steering mechanism is of a type which prevents road reactions from causing the steering wheel to spin. The knob shall be mounted within the periphery of the wheel.

19.8 A-FRAME TRUCKS

19.8.1 ***Design.*** A-frame trucks and similar job-fabricated mobile hoisting equipment shall be designed by a registered professional engineer experienced in the design of such equipment. A written certification attesting that the equipment meets requirements of paragraph 19.8.2 shall be submitted to the Contracting Officer's representative.

19.8.2 *Safety factor.* A minimum safety factor of five shall be incorporated in the design of chains, standing part or guy cables, boom supports, and other load-carrying boom (A-frame) parts. Live or running cable reevings including boom hoist cables, shackles, hooks, and accessories shall have a minimum safety factor of 3.5.

19.8.3 *Testing and capacity plates.* Prior to use, all such equipment shall be load tested at 110 percent of rated capacity on the jobsite and capacity plates installed on the equipment.

19.9 OTHER MECHANIZED CONSTRUCTION EQUIPMENT STANDARDS

19.9.1 *Requirement.* In addition to specific requirements set forth elsewhere in this manual, the requirements set forth in this subsection shall apply to all mechanized equipment and drives both mobile and stationary.

19.9.2 *Guarding.* Belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts of equipment shall be guarded or isolated in order that they do not endanger persons or property. Guarding shall comply with the standards set forth in the current edition of ANSI B15.1, "Safety Standards for Mechanical Power Transmission Apparatus."

19.9.3 *Working platforms.* Equipment shall be provided with adequately designed working platforms, guardrails, and accessories providing a safe footing for operating and maintenance personnel.

19.9.4 ***Fuel tanks.*** Fuel tanks shall be located in a manner which will not permit spills or overflows to contact the engine, exhaust, or electrical parts.

19.9.5 ***Removal of guards.*** Guards and safety devices shall not be removed or rendered ineffective except for necessary repairs or maintenance and then only after the power has been shut off. The guards and safety devices shall be replaced and made operable prior to restarting the equipment.

19.9.6 ***Hot surfaces.*** Hot surfaces of equipment including exhaust pipes, steam pipes, etc., shall be either isolated, guarded, or insulated to prevent contact by persons.

19.9.7 ***Exhaust fumes.*** Exhaust or discharges from equipment shall be confined or controlled so they do not endanger employees or obstruct the operator's view.

19.9.8 ***Rock crushers.*** Rock crushers and similar equipment shall be screened to prevent flying chips or rocks from injuring persons in the vicinity.

19.9.9 ***Vibrating and rocker screens.*** Vibrating or rocker screens shall be equipped with sides and baffles to prevent rock from falling from the screen. Where materials are being processed dry, exhaust systems shall be installed to remove the dust.

19.9.10 ***Tagging and locking.*** Power-driven equipment shall be installed with provision for locking out the controls or switches while under repair. An effective lockout and tagout procedure shall be established prescribing specific responsibilities and procedures to be followed by the person(s) performing the repair work. This type of equipment shall be both locked out and tagged out during repair. For electrically driven equipment, refer to subsection 12.11.

19.9.11 *Certification.* The design of all major facilities and equipment built or provided by the contractor for his use, such as conveyors, materials handling systems, hoists, personnel hoists, manskips, concrete forming support systems for major structures, and similar equipment, shall be certified as structurally suitable for the use intended under the specifications. This certification shall be made in writing by a registered professional engineer competent in these fields and shall be submitted to the Contracting Officer's representative prior to erection or use of such facilities and equipment on the jobsites.

Section 20
BOILERS, COMPRESSORS, AND GAS CYLINDERS

20.1 GENERAL - BOILERS AND COMPRESSORS

20.1.1 ***Design and installation.*** Boilers shall be designed, constructed, installed, tested, and maintained in accordance with the ASME Boiler and Pressure Vessel Code. Compressors and receivers shall be designed, constructed, installed, tested, and maintained in accordance with the ASME "Boiler and Pressure Vessel Code." Prior to installing boilers or moving them into States having boiler codes, the boiler shall be checked for compliance with codes.

20.1.2 ***Inspection and testing.*** Boilers and unfired pressure vessels of every description shall be inspected and tested prior to being placed in service, after any alteration or major repair, and at intervals not exceeding 12 months. Inspection and testing shall be done by qualified personnel. However, for boilers and stationary unfired pressure vessels exceeding 15-lb/in^2 operating pressures, inspection and certification shall be conducted by a Federal, State, or insurance company inspector qualified to inspect and certify the soundness of the vessel.

20.1.3 ***Piping.*** Piping on boiler and unfired pressure vessel systems shall comply with the standards set forth in ANSI B31.1, "Code for Power Piping."

20.1.4 ***Hydrostatic testing.*** Hydrostatic testing of stationary unfired pressure vessels shall be performed when installed and prior to use (new units tested and stamped at factory are exempt from initial test), following major repairs or modifications, and at least every 3 years. The hydrostatic test shall be done in accordance with the ASME "Boiler and Pressure Vessel Code." The following classes or types of unfired pressure vessels are exempt from the requirement:

a. Vessels designed for maximum allowable pressures not exceeding 15 lb/in².

b. Vessels with a maximum allowable pressure of 100 lb/in² or less and an internal volume of not more than 5 cubic feet.

c. Compression tanks containing water under pressures not exceeding 100 lb/in² and temperatures not exceeding 200 °F.

d. Compression tanks containing water and fitted with a permanent air charging line subject to pressures not exceeding 15 lb/in² and temperatures not exceeding 200 °F.

e. Fire extinguishers.

20.1.5 ***Testing with air.*** Tests for structural integrity or leaks using pressurized air or other gases are prohibited except in the testing of bulk POL storage tanks following American Petroleum Institute (API) standards.

20.1.6 ***Pressure gage.*** All pressurized equipment and systems shall be equipped with an approved-type pressure gage.

20.1.7 ***Safety relief valves.*** Approved safety or relief valves shall be installed on all pressurized equipment and systems. The relieving capacity of safety valves shall be enough to limit the system to 10 percent above the maximum allowable working pressure. No valve shall be placed between the pressure vessel and the safety or relief valve, nor between the relief valve and the atmosphere. Safety or relief valves shall be adjusted, tested, and properly sealed by qualified persons.

20.1.8 ***Relief valve malfunction.*** If the pressure registers above the maximum allowable working pressure on the gage without the relief valve operating, the gage and relief valve shall be checked immediately. If the relief valve is inoperative or out of adjustment, pressure shall be relieved and the relief valve adjusted or replaced.

20.1.9 ***Relief valve setting.*** A setting of not more than 10 percent over working pressure is recommended. However, in no event shall the safety relief valve be set higher than the maximum allowable working pressure.

20.1.10 ***Safety devices.*** No safety appliance or device shall be removed or made inoperative unless the pressure has been relieved and the power shut off.

20.1.11 ***Controls.*** Safety relief valves, master valves, water column valves, try cocks, and controls shall be located to permit operation from floor level or provided with safe access.

20.1.12 ***Blowoffs.*** Discharge from safety valves, relief valves, and blowoffs shall be located so they do not endanger personnel.

20.1.13 ***Repair and maintenance.*** Pressurized equipment shall be operated and maintained by designated qualified personnel. Repairs shall not be made when the equipment is under pressure. Pressurized equipment found to be in unsafe operating condition shall be tagged at the controls **OUT OF SERVICE-DO NOT USE.**

20.1.14 ***Handheld equipment.*** Manually held pressurized tools or equipment, subject to whipping or rotation if released, shall be equipped with automatic shutoffs or controls of the deadman type.

20.1.15 ***Pilot check valves.*** Pressurized cylinders on equipment-actuated booms, outriggers, or other load-supporting appliances shall be equipped with pilot check valves, holding valves, or positive-acting, mechanical-locking devices to prevent movement in event the pressure system fails or malfunctions.

20.2 COMPRESSORS AND RECEIVERS

20.2.1 ***Design and installation.*** Unfired pressure vessels, including air compressors, receivers, controls, safety valves, and component parts, shall be constructed, installed, tested, and maintained in accordance with the ASME "Code for Unfired Pressure Vessels." Hydrostatic tests shall be made in accordance with the requirements set forth in paragraph 20.1.4.

20.2.2 ***Drain valves.*** A readily accessible drain valve shall be installed on the lowest point of every air receiver to remove accumulations of oil and water. Operation of the valve shall be as recommended by the manufacturer to remove accumulations of liquid.

20.2.3 ***Piping.*** Piping shall be installed with traps or other effective means of removing liquid from the lines. Air discharge piping shall be installed to eliminate possible oil pockets.

20.2.4 ***Stop valves.*** A stop valve shall be installed between the receiver and each piece of stationary utilization equipment and also at each outlet to which an air hose may be attached.

20.2.5 ***Air receivers.*** Air receivers shall be installed in locations providing convenient access for maintenance. Drains, handholes, and manholes shall be easily accessible. Receivers shall not be buried underground or located in damp locations. The receiver should be located in a cool place to facilitate condensation of moisture and oil vapors.

20.2.6 ***Flammable and toxic gases.*** The compressor intake shall be located to prevent any possibility of flammable or toxic gas, vapor, or dust from being drawn into the compressor.

20.2.7 ***Air intake.*** No valve shall be installed in the air intake pipe to an air compressor with an atmospheric intake.

20.2.8 ***Discharge piping.*** Air discharge piping from the compressor to the receiver shall be at least as large in diameter as the discharge opening on the compressor. If a stop valve is installed between the compressor and the receiver, spring-loaded safety valves shall be installed between the stop valve and the compressor. The total capacity of the safety valves shall be sufficient to limit pressures in the air discharge piping to less than 10 percent above the working pressure of the piping.

20.2.9 ***Hose and hose connections.*** Compressed-air hose and hose connections shall be designed for the pressure and service to which they are subjected.

20.2.10 ***Governors.*** A speed governor, independent of the unloaders, shall be installed on all compressors except those driven by electric synchronous motors. Engine- or turbine-driven compressors shall be equipped with an auxiliary control to the governor to prevent racing when the unloader operates.

20.2.11 ***Limit and bypass.*** Every air compressor shall automatically stop compressing before the discharge pressure exceeds the maximum allowable working pressure of the weakest portion of the system. Electrical contacts shall be designed and installed so that they cannot lock or fuse in a position that would permit the compressor to continue compressing when the allowable pressure is exceeded. An air bypass and alarm may be installed as a substitute for the automatic stop system. Each stage of a multistage compressor shall be equipped with a safety relief valve.

20.3 BOILERS

20.3.1 ***Requirement.*** Boilers and fired pressure vessels shall be designed, constructed, installed, operated, and maintained in accordance with the standards of the ASME "Boiler and Pressure Vessel Code." Prior to being placed in operation, they shall be inspected and certified as provided in paragraph 20.1.2.

20.3.2 ***Startup.*** Initial startup shall be monitored. An operator shall be in constant attendance until the controls have functioned properly through several cycles.

20.3.3 ***Fusible plugs.*** Fusible plugs shall be installed on all boilers, other than those of the water-tube-type, and shall be replaced annually during inspection and certification. When it is necessary to renew fusible plugs between annual inspections, a written report shall be submitted to the boiler inspector setting forth the circumstances and the number and make of the plugs replaced.

20.3.4 ***Blowoff valves.*** Boilers shall be equipped with approved blowoff cocks or valves, and they shall be operated at least once a day.

20.3.5 ***Gages.*** All boilers shall be equipped with approved water columns, gage glass, and try cocks. The gage glasses and water columns shall be guarded to prevent accidental breakage.

20.3.6 ***Aquastat.*** Gas- or oil-fired boilers shall be equipped with an aquastat or similar safety device which will automatically turn off the fuel supply and ignition in event of a feed water failure.

20.3.7 ***Feedlines.*** Feedlines shall be installed with stop and check valves as provided in the ASME "Boiler and Pressure Vessel Code."

20.3.8 ***Housekeeping.*** The boiler room or operating area shall be kept clean and orderly and maintained free of accumulations of oil and grease.

20.4 COMPRESSED GAS CYLINDERS

20.4.1 ***Requirement.*** Compressed gas cylinders shall be constructed, inspected, and tested in accordance with Department of Transportation requirements.

20.4.2 ***Cylinder storage.*** Onsite storage of gas cylinders shall conform to the following requirements.

a. Separation. Cylinders containing the same gas shall be stored in segregated groups and not mixed with other gas cylinders. Empty gas cylinders shall be stored in the same manner.

b. Confined spaces. Cylinders shall be stored in well-ventilated spaces. Cylinders containing oxygen, acetylene, or fuel gases shall not be stored or taken into confined spaces.

c. Flammable or combustible material. Cylinders in storage shall be separated from flammable or combustible material by at least 20 feet or by a fire-resistive partition of at least 1-hour fire resistive rating.

d. Oxidizing gases. Cylinders containing oxygen or oxidizing gases shall be separated from fuel gas cylinders by at least 20 feet or by a fire-resistive partition of at least 1-hour fire-resistive rating.

e. Smoking restrictions. Smoking or open flame shall not be permitted where cylinders are stored and the area posted with **DANGER - NO SMOKING OR OPEN FLAME** signs.

f. Toxic gas. Areas containing toxic gas in storage shall be appropriately posted.

20.4.3 ***Upright position.*** Compressed gas cylinders shall be secured in an upright position at all times except when being hoisted.

20.4.4 ***Cylinder valves.*** Cylinder valves shall be closed when cylinders are in storage, in transit, or not in use.

20.4.5 ***Valve caps.*** Cylinder valve caps shall be securely in place during storage, transit, and at all times when the regulator is not connected to the cylinder.

20.4.6 ***Transporting.*** Compressed gas cylinders transported by crane, hoist, or derrick shall be transported in cradles, nets, or skips; never directly by slings, chains, or magnets.

20.4.7 ***Valve wrenches.*** The valve wrench or wheel shall be in the operating position when the cylinder is in use.

20.4.8 ***Restricted use.*** Cylinders shall be used only for the designated purpose of containing a specific type of compressed gas for which they were designed. They shall be refilled only by the supplier.

20.4.9 ***Handling.*** Cylinders shall be handled in a manner which will not weaken or damage the cylinder or valve. They shall not be exposed to extremes of temperature, physical damage, or electrical current.

20.4.10 ***Oxygen.*** Oxygen cylinders and fittings shall be kept free of oil or grease and shall not be handled with oily hands or gloves. Oxygen shall not be directed at oily surfaces, greasy cloths, or into a container, storage tank, or vessel. Oxygen or other compressed gases shall not be used as a substitute for compressed air.

20.4.11 ***Defective cylinders.*** Leaking cylinders shall be removed to an isolated location out of doors, away from personnel and sources of ignition. The valve shall then be cracked, permitting the gas to escape slowly. The cylinder shall be tagged **DEFECTIVE** and returned to the supplier. Leaking cylinders containing toxic gas shall be handled only by qualified personnel protected by appropriate personal protective equipment.

Section 21

WELDING AND CUTTING

21.1 GENERAL

21.1.1 ***Applicable standards.*** All welding and cutting apparatus, equipment, and operations shall be in accordance with the standards and recommendations set forth in the current edition of ANSI Z49.1, "Safety in Welding and Cutting," and the requirements of this section.

21.1.2 ***Daily inspection.*** Welding apparatus and equipment shall be inspected daily prior to use. Defective apparatus and equipment shall be removed from service, replaced, or repaired and reinspected before being used again.

21.1.3 ***Fire extinguishers.*** Fire extinguishers rated 5 B:C units or larger shall be immediately available wherever welding or cutting is being carried out.

21.1.4 ***Fire protection.*** The following precautions shall be taken, as applicable, when welding or cutting.

a. Flammable material. Welding shall, whenever possible, be confined to areas free of combustible materials. When this is not possible, all combustible material shall be removed or protected from heat, sparks, and slag.

b. Fire guards. When welding, cutting, or heating is such that normal fire prevention precautions are not considered adequate, fire guards shall be assigned to the operation. They shall be on duty during the operations and for a sufficient period of time following the completion of the work to ensure that no possibility of fire exists. Fire guards shall be provided with necessary fire protection equipment and instructed in its use.

c. Tests. Before welding, cutting, or heating any material covered by a preservative coating whose flammability is unknown, a test shall be made to determine its flammability.

d. Shafts. Noncombustible barriers shall be installed below welding or burning operations in or over a shaft or rise.

e. Flammable and combustible liquids. No welding, cutting, or burning shall be done in areas containing flammable and/or combustible liquids, vapors, or dusts.

21.1.5 ***Goggles and protective clothing.*** Welders and helpers shall wear protective clothing and eye protection as specified in subsections 8.3 and 8.6. Further, other persons shall be protected from exposure to welding rays, flashes, sparks, molten metal, and slag. Welding screens shall be installed in repair shops and other areas where welding is done regularly.

21.1.6 ***Preservative coatings.*** When preservative coatings are highly flammable, they shall be removed from the area to be heated in order to prevent ignition. The following precautions shall be taken when the coatings are determined to be toxic.

a. Enclosed spaces. All coated surfaces shall be stripped of the coating for a distance of at least 4 inches from the area of heat application or the employees protected by air line respirators meeting the requirements of section 8.

b. Open air. Employees in open air shall be protected by either an air line respirator or an appropriate respirator meeting the requirements of section 8.

21.1.7 ***Ventilation.*** Ventilation and protection of employees welding, cutting, or heating in confined spaces shall conform to the following requirements:

a. General requirement. Either general mechanical or local exhaust ventilation shall be provided when welding, cutting, or heating is performed in confined spaces. Either system shall be of sufficient capacity and so arranged as to remove the smoke and fumes from the breathing zone and to maintain them within the safe limits as set forth in subsection 7.10. When sufficient ventilation or required fume or smoke removal cannot be obtained by either of these methods, employees shall be provided with appropriate respiratory protection as set forth in subsection 8.4.

b. Toxic materials. Welding, cutting, or heating in any enclosed space involving metals listed below shall be performed with local exhaust ventilation or employees shall wear air line respirators:

(1) Metals containing lead or zinc, or coated with lead-bearing or zinc-bearing materials.

(2) Cadmium-bearing or cadmium-coated base metals.

(3) Metals coated with mercury-bearing metal or material.

(4) Work involving beryllium base or filler metals shall be done with both local exhaust ventilation and air line respirators.

c. Open air. Employees welding, cutting, or heating metals listed in "b" in the open air shall be protected by appropriate filter respirators as set forth in subsection 8.4. Air line respirators shall be required for beryllium base or filler metals.

d. Other employees. Other employees exposed in the same atmosphere as the welders or burners shall be protected in the same manner as the welder or burner.

21.1.8 ***Flammable liquid containers.*** When it is necessary to cut or weld closed containers which contained flammable liquids, the containers shall be thoroughly steam cleaned and then filled with water prior to cutting or welding. Recommendations contained in the pamphlet "Safe Practices for Welding and Cutting Containers That Have Held Combustibles," published by the American Welding Society, shall be followed in performing this type of work.

21.2 GAS WELDING AND CUTTING

21.2.1 ***Equipment.*** Gas welding and cutting equipment shall be as listed by Underwriters Laboratories, Inc., or by Factory Mutual Laboratories.

21.2.2 ***Gas cylinders.*** Gas cylinders shall be constructed, transported, handled, stored, used, and maintained as set forth in subsection 20.4.

21.2.3 ***Regulators.*** Pressure-reducing regulators shall be used only for the gas for which they were designed. Except for cracking the valve slightly to remove dust or dirt, gas shall not be released from a cylinder under pressure without attaching the pressure-reducing regulator to the cylinder valve. Acetylene regulators shall not be adjusted to permit a discharge greater than 15 lb/in^2 (gage).

21.2.4 ***Torches.*** Torch valves shall be closed and the gas supply shut off when work is suspended. Torch valves shall be checked for leaks at the beginning of each shift. Torches shall be lighted by friction lighters or other approved devices and not by matches or from hot work.

21.2.5 ***Check valves.*** All oxygen, acetylene, or other fuel gas-oxygen combinations used in cutting or welding shall have reverse flow check valves installed between the hose and regulator.

21.2.6 ***Welding hose.*** Only properly marked and identified hose in good condition and specifically manufactured for oxyacetylene service shall be used for gas welding and cutting. Hose, which has been subjected to flashback or which indicates evidence of severe wear or damage, shall be removed from service. Containers used for storage of fuel gas hose shall be ventilated.

21.3 ARC WELDING AND CUTTING

21.3.1 ***Applicable standards.*** Electric arc welding apparatus shall comply with the National Electrical Manufacturers' Association "Electric Arc Welding Machine Standards" and shall be installed, operated, and maintained in accordance with ANSI Z49.1, "Safety in Welding and Cutting."

21.3.2 ***Power circuits.*** Power circuits for electric arc welding equipment shall be installed and maintained in accordance with applicable provisions of the current National Electrical Code.

21.3.3 ***Grounding.*** Frames of all electric welding machines operated from power circuits shall be effectively grounded in accordance with current NEC Standards. The ground for electric welding circuits shall be both mechanically and electrically adequate. Pipelines containing gases or flammable liquids and electrical conduits shall not be used for a ground.

21.3.4 ***Cables.*** Splices or repaired insulation shall not be permitted within 10 feet of the electrode holder. Cables shall be positioned so as not to create obstructions on walkways, scaffolds, stairs, or ladders.

21.3.5 ***Gasoline-driven arc welders.*** Gasoline-driven arc welders shall not be used underground in tunnels, shafts, conduits, etc. They shall be equipped with effective exhaust ducts when operated in confined spaces.

21.4 INERT-GAS METAL-ARC WELDING

21.4.1 ***Chlorinated solvents.*** Application of chlorinated solvents shall not be done within 200 feet of the exposed arc. Surfaces prepared with chlorinated solvents shall be thoroughly dry before welding is permitted on such surfaces.

21.4.2 ***Arc protection.*** Employees exposed to the arc shall be required to wear goggles with filter lenses. When two or more welders are exposed to each other's arc, filter lens goggles of suitable type shall be worn under the welding helmets. Hand shields designed to dissipate radiant energy shall be used when either the helmet is lifted or the shield is removed.

21.4.3 ***Radiation.*** Welders and persons exposed to radiation shall wear protective clothing completely covering the skin to prevent harmful effects of ultraviolet rays.

21.4.4 ***Stainless steel.*** When inert-gas metal-arc welding is performed on stainless steel, local exhaust ventilation or air line respirators shall be used.

Section 22

EXCAVATION OPERATIONS

22.1 PRELIMINARY CONSIDERATIONS

21.1.1 ***Preliminary inspection.*** Prior to excavation, the site shall be thoroughly inspected to determine conditions requiring special safety measures. The location of underground installations such as sewer, telephone, gas, water, electric lines, etc. shall be determined and plainly staked. Necessary arrangements shall be made with the utility company or owner for the protection, removal, or relocation of the underground installations. In such circumstances, excavation shall be done in a manner that does not endanger the underground installation or the employees' engaged in the work. Utilities left in place shall be protected by barricading, shoring, suspension, or other measures as necessary.

22.1.2 ***Protection of public.*** Necessary barricades, walkways, lighting, and posting shall be provided for the protection of the public prior to the start of excavation operations.

22.1.3 ***Access and lighting.*** Safe access shall be provided for employees including installation of walkways, stairs, ladders, etc. When operations are conducted during hours of darkness, adequate lighting shall be provided at the excavation site, borrow pits, and waste areas. (Refer to paragraph 7.11.6.)

22.1.4 ***Personal protective equipment.*** Personal protective equipment shall be provided and used in accordance with the specific requirements set forth in section 8. Employees exposed to occupational health hazards shall be protected as set forth in section 7. Drillers and helpers shall wear approved safety goggles or safety glasses with side shields.

22.1.5 ***Removal of trees and brush.*** Prior to excavation; trees, brush, boulders, and other surface encumbrances presenting a hazard to employees shall be removed.

22.2 EXCAVATION REQUIREMENTS (All Excavation Operations)

22.2.1 ***Slide protection.*** The sides of all excavations over 5 feet in depth, unless in solid rock, hard shale, hardpan, cemented sand or gravel, or similar material in which there is no possibility of movement or cave-in, shall be benched, sloped to the angle of repose, or protected by an effective supporting system as set forth in paragraph 22.2.3. Excavations shall be inspected by a competent person following rainstorms or other hazard-increasing occurrences and protection from possible slides or cave-ins increased as necessary.

22.2.2 ***Angle of repose.*** The determination of the angle of repose and design of supporting systems shall be based upon a thorough evaluation of all pertinent factors, including: depth of cut; possible variation in water content of the material; anticipated changes in the material from exposure to air, sun, water, or freezing; loading imposed by structures, equipment, overlying, or stored material; vibrations from sources such as traffic, equipment, and blasting. The angle of repose for all excavations, including trenching, shall be determined by a qualified person, but in no event shall the slope be less than 0.75 to 1 (i.e., 37°) from the bottom of the excavation. Should any question arise over the sloping or the installation of shoring for safety of personnel, the decision of the Contracting Officer's representative shall prevail.

22.2.3 ***Supporting systems.*** The design of supporting systems, i.e., piling, cribbing, shoring, etc., shall be based upon calculations of the forces and their direction with consideration for surcharges, angle of internal friction of materials, and other pertinent characteristics of the material to be retained. When tight sheeting or sheet piling is used, full loading due to the ground-water table shall be assumed unless relieved by weep holes, drains, or other means. Additional stringers, ties and bracing shall be provided to allow for any necessary temporary removal of individual supports. Support systems shall be planned and designed by a professional engineer competent in the field.

22.2.4 ***Structure foundations and footings.*** Except in hard rock, excavations below the level of the base of any foundation, footing, or retaining wall shall not be permitted unless the wall is underpinned and all necessary precautions taken to ensure the stability of the adjacent walls. If the excavation endangers the stability of adjacent buildings or structures; shoring, bracing, or underpinning designed by a qualified person shall be installed. Such supporting systems shall be inspected at least daily by qualified persons to ensure that the protection is adequate and effectively maintained.

22.2.5 ***Vertical cuts and slopes.*** Employees working below steep slopes shall be protected from rock, earth, or other falling or rolling material in the following manners.

a. Scaling. By effective scaling performed prior to exposure and at intervals necessary to eliminate the danger.

b. Rock bolting. Rock bolting, wire mesh, or equivalent support shall be installed when material continues to ravel and fall following thorough scaling.

c. Barricades. Protective timber or wire mesh barricades shall be installed at the top of the cut and at necessary intervals down the slope.

d. Benching. Wherever practical, benching sufficient to retain falling material may be used in lieu of barricades.

e. Placement of personnel. Excavation personnel shall not be permitted to work above one another where danger of falling rock or earth exists.

22.2.6 *Access.* Where employees are required to enter excavations over 4 feet in depth; stairs, ladders, or ramps shall be provided so as to require no more than 25 feet of lateral travel. When access to excavations exceeds 20 feet vertically; ramps, stairs, or man hoists shall be provided for access. At least two means of exit shall be provided. Where the width of the excavation exceeds 100 feet, two or more exits shall be provided on each side of the excavation.

22.2.7 ***Support materials.*** Materials used for sheeting, piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition and timbers shall be sound and free of large or loose knots.

22.2.8. ***Backfilled excavation.*** Special precaution shall be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or fill.

22.2.9 ***Ground water.*** Ground water shall be controlled. Freezing, pumping, drainage, and other major control measures shall be planned and directed by a competent professional engineer. Full consideration shall be given to the existing moisture balances in surrounding soils and the effects on foundations and structures if it is disturbed. When continuous operation of ground water control equipment is necessary, an emergency power source shall be provided.

22.2.10 ***Surface water.*** Water shall not be permitted to accumulate in excavations. Diversion ditches, dikes, dewatering sumps, or other effective means shall be used to control surface water.

22.2.11 ***Crossovers.*** Walkways or bridges protected by standard guardrails shall be provided where employees are required or permitted to cross over excavations.

22.2.12 ***Undercuts.*** When it is necessary to undercut a slope or vertical cut, the overhanging material shall be adequately supported.

22.2.13 ***Excavated materials.*** Excavated materials shall be placed and retained at least 2 feet from the edge of the excavation and at a distance adequate to prevent hazardous loading on the face of the excavation.

22.2.14. ***Protective devices.*** Guardrails, fences, or barricades and warning lights or other illumination maintained from sunset to sunrise shall be provided on excavations adjacent to walkways, driveways, and other pedestrian or vehicle thoroughfares. Wells, calyx holes, pits, shafts, and all similar hazardous excavations shall be effectively barricaded or covered and posted. All temporary excavations of this type shall be backfilled as soon as possible.

22.2.15 ***Stoplogs.*** When mobile equipment is permitted adjacent to excavations with steep slopes or cuts, substantial stoplogs or barricades shall be installed.

22.2.16 ***Equipment operation.*** Unless equipped with an automatic back-up alarm, competent signalmen shall be employed at the loading site and the waste area when it is necessary to back earthmoving equipment. When dumping in waste areas where backing may endanger employees, a competent signalman shall be used. If the equipment or truck cab is not shielded as provided in paragraph 19.4.7, the operator shall stand clear of the vehicle during loading. Excavating or hoisting equipment shall not be allowed to raise, lower, or swing loads over workmen unless effective overhead protection is provided.

22.2.17 ***Drilling operations.*** When drilling in rock or other dust-producing material, the dust shall be controlled within the safe limits specified in the current edition of "Threshold Limit Values of Airborne Contaminants," published by the American Conference of Governmental Hygienists. Percussion drilling shall be performed with drilling apparatus equipped with water or chemical dust control systems or other equivalent means of controlling the dust. Except in shaft and tunnel excavation, dust control devices are not required on jackhammers provided the operators wear approved-type dust respirators.

22.2.18 ***Scaling.*** Scaling shall be performed by experienced crews under direct supervision of a competent supervisor. Refer to subsection 8.8, Construction Safety Belts and Lines.

22.3 TRENCH EXCAVATION

22.3.1 ***Requirement.*** All trench excavation over 5 feet in depth, unless in solid rock, hard shale, hardpan, cemented sand or gravel, or similar stable material in which there is no possibility of movement or cave-in, shall be either supported as provided in paragraph 22.3.2 or sloped to the angle of repose from botton of trench, but never less than 0.75 to 1 (i.e., 37°). Should any question arise of the sloping or the installation of support systems, the decision of the Contracting Officer's representative shall prevail.

22.3.2 ***Support systems.*** Sheeting, sheet piling, bracing, shoring, trench boxes, and other methods of trench protection shall be designed by a professional engineer competent in the field, and installed by qualified persons. The design shall be based on the calculated pressures exerted by and the condition and nature of the materials to be retained. These calculations shall also include the surcharge imparted to the sides of the trench by equipment and stored materials.

22.3.3 ***Shoring specifications.*** The support system or shoring shall conform to the minimum requirements set forth in appendix Y, Trench Shoring - Minimum Requirements. Braces and diagonal shores in a timber shoring system shall not be subjected to compressive stresses in excess of the values given in the following formula:

$$S = 1300 - \frac{20L}{D}$$

$$\text{maximum ratio } \frac{L}{D} = 50$$

where:

L = length, unsupported, in inches
D = least dimension of timber, in inches
S = allowable stress of cross section, in pounds per square inch

22.3.4 ***Acceptable shoring design.*** Appendix Z, Shoring Design, figures 1 through 6 illustrate acceptable design and installation of shoring for varying depths and soil conditions. These are minimum requirements and all support systems shall meet or exceed the design illustrated in figures 1 through 6.

22.3.5 ***Trench boxes.*** Portable trench boxes, sliding trench boxes, and shields shall be designed, constructed, and maintained in a manner which will provide equivalent protection to shoring and sheathing required for the same conditions.

22.3.6 ***Benching.*** In hard or compact soils, sloping may not be required to be carried to the bottom of the trench providing a bench of 4-foot-minimum width is provided at the toe or bottom of the sloped portion of the trench. This provision is to accommodate pipe laying and in no event shall the height of the unsloped portion of the trench exceed the outside diameter of the pipe. Application of this procedure shall be subject to prior approval of the Contracting Officer's representative and only under conditions not endangering the safety of employees.

22.3.7 ***Placement of shoring.*** Bracing and shoring shall be carried along with the excavation and shall not be omitted where the depth of trench and soil conditions require shoring or bracing. Where a backhoe or ditching machine is used, the shoring or trench box shall be placed as close as possible to the lower end of the boom.

22.3.8 ***Removal of support.*** Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly. In unstable soil, ropes or other safe means shall be used to remove the braces from above after the employees have left the trench.

22.3.9 ***Ladders.*** Where employees are required to work in trenches over 4 feet in depth, ladders extending from the bottom of the trench to at least 3 feet above the top shall be placed within 25 feet of the employees in the trench.

22.3.10 ***Cross braces and jacks.*** Cross braces and trench jacks shall be placed in true horizontal position and secured to prevent sliding, falling, or kickouts.

22.4 STRUCTURE FOOTINGS

22.4.1 ***Requirement.*** Small diameter footings, including bell-bottom footings, over 4 feet deep which employees are required to enter shall be provided with a steel casing or support system of sufficient strength to support the earth walls and prevent cave-ins. The casing or support system shall be provided the full depth except for the bell portion of bell footings.

22.4.2 ***Access.*** Fixed or portable ladders shall be provided for access. A lifeline securely attached to a shoulder harness shall be worn by every employee entering the footing. The lifeline shall be manned from above and shall be separate from any line used to raise or lower materials.

22.5 COFFERDAMS

22.5.1 ***Controlled flooding.*** Where overtopping of a cofferdam is possible, the design shall provide for controlled flooding of the work area. Further, an evacuation plan, including installation of warning signals and emergency exits, shall be devised for the safe evacuation of personnel and equipment from the work area.

22.5.2 ***Walkways and guardrails.*** Where employees are permitted on cofferdams, safe walkways protected by guardrails shall be installed.

22.5.3 ***Exit.*** A rapid means of exit shall be provided for personnel and equipment working on cofferdams.

Section 23

TUNNELS AND SHAFTS

23.1 GENERAL

23.1.1 ***Requirement.*** In addition to the safety requirements set forth in this section and other parts of this manual, tunnel and shaft excavation and construction shall be performed in compliance with applicable provisions of the contract.

23.1.2 ***Access.*** Safe means of access shall be provided and maintained to all work areas. Access to shafts shall be protected by gates, barricades, or doors. Unused manways, or other openings, shall be covered, bulkheaded, or fenced-off, and posted.

23.1.3 ***Employee identification.*** A check-in and checkout system shall be maintained on each shift which will provide positive identification of every employee underground. An accurate record and location of employees working underground shall be maintained on the surface.

23.1.4 ***Illumination.*** Underground lighting and illumination intensities shall be provided as set forth in subsection 7.11, Lighting. Light fixtures shall be nonmetallic and lighting conductors shall be supported on insulators located on the side of the tunnel or shaft opposite the firing line.

23.1.5 ***Electrical equipment.*** Electrical wiring and equipment shall conform to the requirements set forth in section 12. Only dry-type transformers shall be permitted underground and they shall be protected from possible damage. Powerlines shall be separated or insulated from air and waterlines, metal ducts, and telephone lines.

23.1.6 ***Bonding and grounding.*** Air and water piping, metal vent pipe, rails, and similar conductive devices shall be grounded and bonded at the portal or shaft head and at intervals not exceeding 1000 feet.

23.1.7 ***Telephones.*** A telephone or similar communication system shall be installed between the heading, the portal or shaft head, and first-aid station.

23.1.8 ***Blasting.*** Blasting and explosive-handling operations shall conform to the requirements set forth in section 24.

23.1.9 ***Wet conditions.*** Employees working in wet underground areas shall wear safety-toed rubber boots and rain gear.

23.2 EMERGENCY PROVISIONS

23.2.1 ***Evacuation plan.*** Emergency evacuation plans including provisions for rescue equipment shall be developed, posted at the portal or shaft head, and employees instructed in the procedure.

23.2.2 ***Self-rescuers.*** MSHA-approved self-rescuers shall be available at the heading and other work areas of underground operations. There shall be at least one adequately maintained and readily available self-rescuer for each employee.

23.2.3 ***Emergency hoists.*** Unless the hoisting equipment is independent of electrical power failures, emergency hoisting facilities shall be provided in shafts over 50 feet in depth.

23.2.4 ***Rescue crews.*** Tunnel and shaft operations employing 25 or more employees at one time underground shall have at least two rescue crews of at least five men in each crew. The crews shall be instructed and trained in the rescue procedures and in the use and care of oxygen-breathing apparatus and fire-fighting equipment. Not less than one crew of at least five employees shall be organized and trained as a rescue crew on smaller operations. New crew members shall be thoroughly instructed and refresher training for the full crew conducted at least every 6 months.

23.3 VENTILATION

23.3.1 ***Requirement.*** The tunnel ventilation system shall be of sufficient capacity to (1) maintain an adequate supply of uncontaminated pure air in all parts of the tunnel, (2) provide for the size and design of equipment to be used, (3) control airborne contaminants within the threshold limit values, and (4) tunnel air velocity shall be maintained at the required flow but in no case shall it be less than 100 feet per minute over the gross tunnel bore area. Forced mechanical ventilation shall be maintained after holing through in order to ensure compliance with these requirements.

23.3.2 ***Design.*** The system design, specifications, and drawings shall be submitted for the Contracting Officer's approval prior to the acquisition and installation of the ventilation and exhaust system. Refer to appendix DD, Tunnel Ventilation Design Criteria, which sets forth the information required by the Contracting Office. The system airflow direction to tunnel face, including all fans shall be reversible from surface locations. Electric motors, fan, drive, and auxiliary equipment shall be explosion-proof type and maintained in explosion-proof condition.

23.3.3 ***Air velocity measurement.*** Air velocity measurements shall be made, recorded, and available immediately following installation and at least once each day shift in order to ensure compliance with the established minimum airflow requirement.

23.4 TOXIC AND FLAMMABLE GASES

23.4.1 ***Requirement.*** Concentrations of toxic and flammable gases shall not exceed the following limits:

a. Carbon monoxide. Fifty parts per million (0.005 percent) in the general tunnel or shaft atmosphere.

b. Nitrogen dioxide. Five parts per million (0.0005 percent) in the general tunnel or shaft atmosphere.

c. Hydrogen sulfide. Ten parts per million (0.001 percent) in the general tunnel or shaft atmosphere.

d. Methane. One and one-half percent at the heading and 1 percent in the general tunnel or shaft atmosphere, measured within 12 inches of the crown of the tunnel.

e. Other flammable gases. Forty percent of the lower explosive limit at the heading and 20 percent of the lower explosive limit in the general tunnel or shaft atmosphere.

23.4.2 ***Testing.*** In addition to making air velocity measurements, the contractor shall obtain and use approved testing devices for determining concentrations of carbon monoxide, nitrogen dioxide, and oxygen content. Tests for determining concentrations of carbon monoxide, nitrogen dioxide, and oxygen content shall be made after each blast and at scheduled intervals on each shift. Records of test readings shall be maintained and made available to the Contracting Officer's representative. Similar test procedures shall be established and conducted whenever the presence of other toxic or flammable gases or vapors is known or suspected.

23.4.3 *Instrumentation.* The following types of approved testing devices for determining concentrations of flammable gases and vapors shall be obtained and used by the contractor: (1) Whenever a rapid excavation machine is used, a continuous flammable-gas detector, designed to detect and shut down the excavation operation when concentrations exceed 1 percent by volume, shall be installed. One sensor shall be located at the dust shield in close proximity to the conveyor belt opening, one sensor at the operator's station, and one in the primary duct of the exhaust ventilation system. (2) Where conventional tunneling methods are employed, an automatic continuous flammable-gas detector shall be installed to warn employees when flammable gas concentrations exceed 1 percent by volume. This detector shall have at least one sensor located in the primary duct of an exhausting ventilation system or in the general tunnel area near the face on a supply system. In either case, at least one additional sensor shall be located in the general tunnel area within 30 feet of the face or as directed by the Contracting Officer's representative. (3) In all operations, approved-type portable flammable-gas detectors shall be used by qualified persons to check the atmosphere near the face prior to the start of each shift and at least once every 4 hours thereafter.

23.4.4 *Suspension of operations.* Should flammable gases or vapors exceed the concentrations set forth in paragraph 23.4.1, the following procedure will be implemented:

> All operations shall be immediately suspended and personnel removed from the tunnel or shaft. Reentry, except for rescue operations, shall be prohibited until the following steps

have been taken by the contractor and the Contracting Officer has authorized reentry in writing. Reentry shall not be permitted or authorized until (1) the contractor has engaged the services of a consulting engineer experienced in gaseous tunneling or mining operations, (2) following onsite investigation and testing, the consultant has developed a written procedure, satisfactory to the Contracting Officer, for reentry and resumption of operations, and (3) the procedure complies with all requirements of this manual and regulations of Federal and State entities having jurisdiction.

23.5 DUST CONTROL

23.5.1 ***Requirement.*** Drilling and excavation of every description shall be carried out in a manner which will ensure that concentrations of dust will not exceed the safe hygiene limits as specified in the "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment," published by the American Conference of Governmental Industrial Hygienists.

23.5.2 ***Drilling.*** Rotary and percussion drills shall be equipped with water or chemical dust-control systems or other approved equivalent.

23.5.3 ***Tunnel boring machines.*** Tunnel boring machines shall be equipped with a dust control system approved by the Contracting Officer prior to installation, which is capable of controlling the dust concentrations within the specified safe hygienic limits. The system shall be routinely maintained to ensure its effectiveness.

23.5.4 ***Monitoring.*** Dust concentrations in all dust-producing underground operations shall be monitored as follows: Within 10 days after commencing underground operations, at 90-day intervals thereafter, within 30 days following major changes in tunnel excavation operations, and whenever directed to do so by the Contracting Officer. The monitoring shall be conducted by a qualified person using standard breathing zone and environmental sampling methods. A record of the testing results with supporting calculations shall be submitted to the Contracting Officer's representative within 2 weeks of sampling date.

23.5.5 ***Muck piles.*** Muck piles shall be kept wet to reduce dust concentrations.

23.6 INTERNAL COMBUSTION ENGINES

23.6.1 ***Requirement.*** Internal combustion engines, other than approved mobile diesel-powered equipment, shall not be used underground. Diesel-powered equipment shall be approved and/or certified by MSHA under either Schedule 24 or 31, and when applicable, a permit shall be obtained from the State entity having jurisdiction before the equipment is taken underground.

23.6.2 ***Ventilation requirements.*** Ventilation requirements incident to the use of diesel-powered equipment underground shall comply with MSHA recommendations as set forth in Circulars 5616 and 8183.

23.6.3 ***Maintenance and testing.*** The contractor shall maintain all diesel equipment in safe operating condition, ensuring compliance with the requirements of Circulars 5616 and 8183. In the event the Contracting Officer's representative is of the opinion that these requirements are not being met, the contractor shall perform the tests as set forth in

MSHA Report of Investigations RI-5616 when so directed.

23.7 NOISE CONTROL

23.7.1 ***Requirement.*** A thorough noise survey of all underground operations shall be conducted by a qualified person using an approved Type 2 sound level meter when directed to do so by the Contracting Officer's representative. Should the sound levels exceed the permissible noise exposures set forth in paragraph 7.7.2, the contractor shall initiate and carry out a hearing conservation program in accordance with the requirements of paragraph 7.7.7.

23.8 FIRE PREVENTION AND CONTROL

23.8.1 ***Requirement.*** In addition to the requirements set forth in section 10, "Fire Prevention and Protection," the following requirements shall apply to all underground operations.

23.8.2 ***Heating.*** Heating devices used in tunnels or shafts shall have prior approval of the Contracting Officer's representative. Open-fire, LPG, and natural gas heaters are prohibited.

23.8.3 ***Gasoline, diesel, and LPG.*** Gasoline and liquefied petroleum gases shall not be permitted underground. Not more than 1 day's supply of diesel oil shall be permitted underground.

23.8.4 ***Lubricants.*** Oil and grease stored underground shall be kept in tightly sealed containers in fire-resistant areas at safe distances from other combustible materials and electrical installations.

23.8.5 ***Hydraulic fluids.*** Fire-resistant hydraulic fluids approved by a recognized authority, such as

Underwriters Laboratories, Inc., or Factory Mutual Laboratories, shall be used in hydraulically actuated machinery and equipment, unless the equipment is protected by a fire protection system satisfactory to the Contracting Officer's representative.

23.8.6 ***Belt conveyors.*** Fire extinguishers of at least 10 B:C units shall be provided at the head and tail pulleys and at 300-foot intervals along the belt line.

23.8.7 ***Portal structures.*** All structures erected within 100 feet of a tunnel portal or shaft entrance shall be of fire resistive construction. Flammable material storage areas shall be at least 200 feet from the portal or shaft entrance. Combustible or flammable material shall not be permitted within 100 feet of the main fan installation.

23.9 DRILLING OPERATIONS

23.9.1 ***Examination and scaling.*** Prior to commencing the drill cycle, the face and lifters shall be examined for misfires and if found, they shall be removed before drilling. Lifters shall not be drilled through loose rock or water. The heading, including the face, shall be inspected for loose rock and scaled prior to drilling.

23.9.2 ***Equipment inspection.*** Drilling equipment shall be inspected each shift and defects affecting safety shall be corrected before the equipment is used.

23.9.3 ***Drill jumbos.*** On jumbo decks over 6 feet in height, removable guardrails with pipe uprights and chain handrails, or equivalent protection, shall be installed on the open sides and back. Safe access to the deck shall also be provided and the decks covered with solid nonslip decking. When jumbos are being moved, riders shall not be permitted on the deck unless assisting the operator.

23.9.4 ***Moving drills.*** When a drill is being moved to another area; drill steel, tools, and other equipment shall be secured and the mast secured in a safe position. Receptacles or racks shall be provided for drill steel stored on drill jumbos.

23.9.5 ***Drill masts.*** Employees shall not be permitted on the drill mast when the drill bit is in operation.

23.9.6 ***Column drills.*** Drills supported on columns shall be anchored firmly prior to operation and shall be retightened frequently during operation.

23.9.7. ***Startup warning.*** Before the drill cycle is started, a warning shall be given to employees working below the jumbo deck.

23.9.8 ***Lifting material and equipment.*** A mechanical means shall be provided to raise heavy materials and equipment to the top decks of jumbos over 6 feet in height.

23.9.9 ***Air hose.*** All air hoses exceeding 0.5-inch-inside-diameter shall be secured at each connection and at the drill with a chain or wire rope safety lashing or equivalent safety device. (Refer to paragraph 16.2.2.)

23.9.10 ***Personal protective equipment.*** Personal protective equipment shall be provided and used as set forth in section 8.

23.10 GROUND SUPPORT

23.10.1 ***Tunnel portals.*** Rock faces above and adjacent to portal areas shall be kept thoroughly scaled, and all loose or overhanging rock removed. Chain link fabric shall be provided on rock faces subject to spalling or raveling. A fire-resistive protective canopy shall be provided at all tunnel portals. It shall project at least 15 feet from the portal face and be designed to withstand falling earth or rock.

23.10.2 ***Inspection and scaling.*** Tunnels and shafts where employees are working shall be inspected at least once a shift, and scaled and supported as required. The entire tunnel, including roof and walls, shall be inspected at least weekly by a competent person, and inspection records maintained.

23.10.3 ***Loose ground.*** Loose rock and earth shall be removed or adequately supported.

23.10.4 ***Rock bolting.*** Rock bolt support systems shall be designed by a foundation engineer, a geologist, or other qualified person. Torque meters and torque wrenches shall be available where rock bolts are used. Torque testing and retightening intervals shall be established on the basis of rock conditions and existing vibration sources.

23.10.5 ***Damaged tunnel supports.*** Damaged or dislodged tunnel supports, of any description, shall be immediately repaired or replaced. Whenever possible, new supports shall be installed prior to removing the damaged supports.

23.10.6 ***Anchorage.*** All sets, including horseshoe-shaped or arched rib steel sets, shall be designed and installed with the bottoms sufficiently anchored to prevent movement. Lateral bracing shall be installed between sets to stabilize the support.

23.10.7 ***Timber supports.*** Load-carrying timber supports shall be kiln dried and free of knots, decay, or other defects which would materially decrease their strength. They shall be installed and maintained in a manner to safely support all vertical and lateral loading that might be applied.

23.11 TRANSPORTATION AND HAULAGE

23.11.1 ***Inspection.*** All haulage equipment shall be maintained in safe operating condition and inspected at the beginning of each shift by a qualified person. Equipment defects affecting safe operation shall be corrected before the equipment is used.

23.11.2 ***Lights and alarms.*** Locomotives and mobile haulage equipment shall have headlights, a backup light, and an audible warning device. They shall also be equipped with a continuous revolving, flashing amber light, visible in all directions. Rubber-tired haulage equipment shall have two headlights at both ends, a backup light, and an automatic backup alarm.

23.11.3 ***Safety couplings.*** Mine dump cars shall be equipped with automatic safety couplings and cradle dump cars shall be equipped with a positive locking device to prevent accidental dumping.

23.11.4 ***Man haul.*** Employees, with the exception of train crews, shall not be permitted to ride cars unless the cars are especially adapted for that purpose. Man haul cars shall be provided with seats and overhead protection. Supplies, materials, and equipment, other than small hand tools, shall not be transported with employees in man haul cars. Employees shall not be permitted to get on or off moving cars.

23.11.5 ***Tracks.*** Rails shall be installed and maintained in a manner to prevent shifting or excessive settlement.

23.11.6 ***Speed.*** Maximum safe speeds shall be established for all rail haulage equipment and posted at the operator's station.

23.11.7 ***Dumping.*** Berms, bumper blocks, safety hooks, or equivalent means shall be provided to prevent overtravel and overturning at dumping areas.

23.12 SHAFTS

23.12.1 ***Requirement.*** The following requirements also shall apply to the excavation of shafts.

23.12.2 ***Access.*** Unless specifically waived by the Contracting Officer, all shafts shall be provided with a protected manway designed to permit safe access and egress to and from the heading. Hoisting equipment used to transport personnel shall be designed, installed, operated, and maintained as set forth in paragraph 23.12.3. Cranes, derricks, or similar hoisting equipment shall not be used to lower or raise personnel. The shaft opening shall be protected with perimeter guarding, equivalent to a standard guardrail and toeboard at least 12 inches high. The entrance to the shaft shall be protected by a self-closing door.

23.12.3 ***Hoisting equipment.*** Hoisting equipment used to transport personnel shall be designed by a licensed professional engineer competent in the field and fully cognizant of the applicable ANSI standards and the requirements of the State having jurisdiction. In addition to the requirements set forth in subsection 18.10, the following requirements and exceptions shall apply to hoisting equipment installed in shafts:

a. Buckets. In addition to cages or man skips, employees may be transported in buckets provided: (1) The sides of the bucket shall be at least

4 feet in height and not less than 1/16-inch-thick metal. (2) Emergency chains, slings, or double clevis pins shall be used between the lower end of the hoisting rope and the bucket to prevent the bucket from falling in event of a ring bolt or clevis pin failure. (3) A bonnet shall be provided that covers the top in such manner to afford protection from falling rock or objects. The bonnet shall be the equivalent of two steel plates 3/16 inch in thickness, sloping toward each side and arranged to permit safe egress from the bucket. Cages and skips shall have equivalent perimeter and overhead protection.

b. Hoist motors. The hoist motor shall be so designed that the load is powered up and down through the gears. There shall be no friction gearing or clutch mechanism by which the motor or other power source can be disconnected from the hoist drum. When the control is brought to the "stop" position or should the motor stop, the load shall stop and remain in the stopped position.

c. Hoist controls. The hoist control shall be designed to return to the "stop" position when the hand of the operator is removed from the control lever. The brakes shall be automatically applied and the power cut off whenever the control lever is in the stop position.

d. Guides. Shafts over 50 feet in depth shall be equipped with guiderails or guide cables to prevent the cage or bucket from swaying.

e. Broken-rope safety. Cages, skips, or buckets operating on guides or guide cables in shafts over 50 feet in depth shall be equipped with a broken-rope safety device, or equivalent, that will stop and hold a capacity load in event of a hoisting cable failure.

f. Limit stop. Hoists shall be equipped with an approved-type limit switch which will automatically cause the cage or bucket to stop at the top limit of travel.

g. Performance test. Following installation and prior to use, and at least every 6 months thereafter, each hoist shall be inspected and tested by a competent person qualified to conduct such tests. The tests shall be carried out at 125 percent of full rated loading and all safety devices shall be tested to determine whether or not they are functioning properly.

23.12.4 ***Overhead protection.*** No material or tools shall be hoisted or lowered while men are working at the bottom of a shaft, unless a barrier of adequate strength is installed to protect them from falling objects or material. No load, cage, skip, bucket, etc., shall be lowered directly to the bottom of a shaft when men are working there. All such equipment shall be stopped at least 15 feet above the bottom of the shaft and remain there until the signal to lower is received from a signalman at the bottom of the shaft.

23.12.5 ***Small-diameter shafts.*** Small-diameter shafts, such as manholes, wells, or test pits in which employees are required to enter, shall be provided with a steel casing, concrete pipe, timber cribbing, or other support adequate to retain the surrounding earth.

23.12.6 ***Inspection.*** Following a blast, the walls, ladders, timbers, blocking, and wedges shall be checked to determine if they have loosened. If they are found to be loose or unsafe, repairs shall be made prior to continuing work in the shaft.

23.13 TUNNELING IN SOIL

23.13.1 ***Support.*** When excavated by conventional methods, the excavation shall not be extended more than 2 feet in advance of the tunnel supports. When continuous mining machines are used, the support shall be kept within 4 feet of the face or shield. No employees shall be permitted under unsupported or unshielded sections of the tunnel.

23.13.2 ***Voids.*** Voids behind ring beams, liner plates, timbering, or other type supports shall be filled, blocked, or braced to prevent caving.

23.13.3 ***Design of support.*** Support systems for tunnels excavated in soil shall be designed by a soils engineer, geologist, or other person experienced in the field.

23.14 COMPRESSED-AIR WORK

23.14.1 ***Requirement.*** The contractor shall comply with the requirements set forth in 29 CFR 1926.803 "Compressed Air," when operations involve work in a compressed-air environment.

Section 24

BLASTING OPERATIONS

24.1 GENERAL

24.1.1 ***Requirement.*** In addition to the requirements of this section, the transportation, handling, storage, and use of explosives shall be subject to the provisions of Subpart U, "Blasting and the Use of Explosives," of the Department of Labor, 29 CFR, Part 1926, and the regulations of the Department of the Treasury contained in 27 CRF 181, "Commerce in Explosives." In case of conflict, the requirements set forth in this section shall prevail.

24.1.2 ***Competent supervision.*** The transportation, handling, storage, and use of dynamite and other explosives, including blasting agents, shall be directed and supervised by persons of proven experience and competency in blasting and use of explosives. Written evidence of the blasting supervisor's past experience shall be furnished the Contracting Officer's representative.

24.1.3 ***Qualifications.*** A blaster shall be qualified, by reason of training, knowledge, or experience, in the field of transporting, storing, handling, and use of explosives, and have a working knowledge of State and local laws and regulations which pertain to explosives. Blasters shall be required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required.

24.1.4 ***Permission required.*** Permission shall be obtained from the Contracting Officer's representative prior to bringing any explosives or blasting agents on the jobsite. Blasting will be permitted only after adequate provision has been made for the protection of persons, the work, and public and private property. Approval by the Contracting Officer or his representatives of the contractor's blasting operations shall not relieve the contractor of his responsibility for the safety of persons and property.

24.1.5 ***Security and inventory.*** The contractor shall provide such reasonable and adequate security as is necessary to prevent loss or theft of explosives. He shall maintain an inventory of all explosives on the jobsite, including a record of explosives received, and withdrawn from the magazines. Such records shall be available to the Contracting Officer's representative, and any loss or theft promptly reported.

24.1.6 ***Notification of owners.*** Blasting operations in the immediate vicinity of buildings, public roads, overhead powerlines, utility services, or similar facilities shall not be undertaken until the owners and/or the operators have been notified and all necessary precautions taken for safe control of the blasting operations.

24.1.7 ***Smoking restrictions.*** Smoking, firearms, matches, open flame lamps, fire, heat-producing devices, and sparks shall be prohibited in or near explosive storage sites or in areas where explosives are being handled, transported, or used.

24.1.8 ***Thunderstorms.*** The handling or use of explosives shall be discontinued during the approach and progress of a thunderstorm. All persons shall be removed from the danger areas to a place of safety during such periods. The contractor shall acquire and use an approved-type lightning warning device capable of detecting atmospheric conditions that could produce lightning.

24.1.9 ***Vibration and damage control.*** Blasting in or adjacent to dams and appurtenant structures; also coffer dams, buildings and other facilities, susceptible to vibration and/or air blast damage, shall be carefully controlled to eliminate any possibility of damage. Where required by the specifications or the Contracting Officer, the contractor shall submit for review and approval a vibration and damage control plan prepared by a recognized blasting specialist. The plan shall incorporate provisions for monitoring blasts with calibrated seismographs containing triaxial orthogonal velocity transducers with a flat frequency response from 2 to 200 Hz to be placed in designated locations and/or structures as specified by the Bureau. The maximum peak particle velocity as recorded by the seismographs at the designated structures or locations shall not exceed 1 inch per second, unless otherwise specified by the Bureau. The seismograph recording or seismogram shall be a real time direct readout permanent record of the vibration measurements and copy shall be submitted to the Contracting Officer's representative.

Air blast shall be controlled so it does not exceed 128 decibel linear-peak at designated locations and/or structures as specified by the Contracting Officer.

24.1.10 ***Warning signs.*** Warning signs shall be posted at access points to blasting areas.

24.1.11 ***Deterioration of explosives.*** Explosives, blasting agents, and blasting supplies that have deteriorated or have been damaged shall be destroyed in a safe manner. They shall not be used.

24.1.12 ***Empty explosive containers.*** Empty boxes and combustible packing materials which have contained explosives shall be destroyed by burning at an approved location or according to manufacturer's recommendation.

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24.2 RADIO AND ELECTROMAGNETIC RADIATION

24.2.1 ***Requirement.*** Adequate precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, powerlines, and similar sources of electromagnetic radiation.

24.2.2 ***Radio transmitters.*** Where the safe clearance distances from RF transmitter stations, as set forth in ANSI C95.4, cannot be observed, blasting shall be done with a totally nonelectric firing system. Electrical detonators shall not be stored or used within the ANSI specified distances from a transmitter station.

24.2.3 ***Mobile radio transmitters.*** Unless deenergized and effectively locked, mobile or portable transmitters shall not be permitted within 100 feet of electric blasting caps or delays not in their original containers. Warning signs at least 36 by 42 inches in size, stating **BLASTING ZONE - TURN OFF 2-WAY RADIOS,** shall be posted on all public roads within 1,000 feet of blasting operations using electric detonators.

24.3 TRANSPORTATION OF EXPLOSIVES

24.3.1 ***Public highways.*** The transportation of explosives by air, water, or on public highways shall comply with the provisions of Department of Transportation Regulations contained in 14 CFR, Part 103, "Air Transportation;" 46 CFR, Parts 146-149, "Water Carriers;" 49 CRF, Parts 171-179, "Highways and Railroads;" 49 CFR, Part 190-195, "Pipelines;" and 49 CFR, Parts 390-397, "Motor Carriers."

24.3.2 ***Vehicles.*** Vehicles used to transport explosives shall conform to the following requirements:

a. They shall be in good repair with all electrical wiring completely protected and securely fastened to prevent short circuits.

b. They shall be thoroughly inspected prior to use to ensure that they are in safe condition and comply with the requirements of this paragraph.

c. They shall have tight floors and any exposed spark-producing metal shall be covered with wood or other nonsparking material to prevent contact with containers of explosives.

d. They shall not be loaded beyond rated capacity and the explosives shall be secured to prevent shifting or dislodgment.

e. In open-body-type vehicles, the explosives shall be covered with a fire-resistant tarpaulin or transported in a Class II magazine.

f. Vehicles transporting explosives shall be marked with reflectorized signs on both sides, the front and rear, with the word **EXPLOSIVES** in red letters not less than 4 inches high on a white background or placarded in accordance with 49 CFR 172, subpart F.

g. They shall be equipped with one or more fire extinguishers having a rating of at least 10 B:C.

24.3.3 ***Vehicle operators.*** Operators of vehicles transporting explosives shall be licensed, physically fit, competent, able to read and understand instructions, and not addicted to the use of intoxicants or narcotics.

24.3.4 ***Caps and detonators.*** Blasting caps and detonators shall not be transported with other explosives, unless the blasting caps or detonators are contained in a closed metal storage container having at least a 2-inch wood lining. Such containers shall be separated at least 2 feet from other explosives.

24.3.5 ***Flammable materials.*** Spark producing tools, carbides, oil, matches, firearms, acids, storage batteries, oxidizing or corrosive compounds, or flammable materials shall not be transported with explosives.

24.3.6 ***Parking.*** Vehicles containing explosives shall not be left unattended nor parked in public garages or other congested areas.

24.3.7 ***Fueling.*** Except in emergency, vehicles carrying explosives shall not be refueled.

24.3.8 ***Smoking restrictions.*** Persons employed in the transportation, handling, or use of explosives shall not smoke or carry on their persons or in the vehicle; matches, lighters, firearms, ammunitions, or flame-producing devices of any description.

24.3.9 ***Riders.*** Only the authorized driver and his helper shall be permitted to ride on trucks transporting explosives or detonators.

24.4 TRANSPORTATION UNDERGROUND

24.4.1 ***Requirement.*** In addition to the requirements set forth in subsection 24.3, the provisions of this subsection shall apply to underground transportation of explosives.

24.4.2 ***Hoists.*** The hoist operator shall be notified before explosives or blasting agents are transported in a shaft conveyance. No persons shall be permitted to ride a hoist or shaft conveyance transporting explosives or blasting agents. Detonators and explosives shall not be transported at the same time.

24.4.3 ***Powder cars and trucks.*** Explosives and blasting agents shall be conveyed only in specifically built or equipped insulated powder cars or truck-mounted containers approved by the State entity having jurisdiction. If explosives and detonators are conveyed in the same vehicle, they shall be separated at least 2 feet by wood or wood-lined partitions, or by at least 6 inches of firmly fastened hardwood, or equivalent. No explosives or blasting agents shall be transported on a locomotive, and at least two car lengths shall separate the locomotive from the powder car. Powder cars shall be pulled, not pushed, whenever possible.

24.4.4 ***Man haul.*** Explosives or blasting agent shall not be transported on the man haul trip. Only the operator, his helper, and the powderman shall be permitted on the powder-haul trip.

24.4.5 ***Truck transportation.*** Trucks transporting explosives underground shall have their electrical systems checked weekly to detect possible electrical hazards. A written record of such inspections shall be maintained. The installation of auxiliary lights on truck beds, which are powered by the truck's electrical system, are prohibited. Explosives shall not be stored in trucks.

24.4.6 ***Transportation to face or loading area.*** Only the quantity of explosives or blasting agents estimated necessary for the blast shall be taken to the face or loading area. Explosives or blasting agents shall not be taken to the loading area until the drilling has been completed and the holes are ready to be loaded. Surplus explosives and blasting agents shall be removed from the area prior to wiring-up the blast.

24.4.7 ***Makeups.*** Unless a primer-make-up-plan is submitted and approved by the Contracting Officer, primers and delays shall be made up at the face or loading area.

24.5 STORAGE OF EXPLOSIVE

24.5.1 ***Requirement.*** Explosives and related materials shall be stored in approved magazines, and in accordance with the applicable provisions of the Bureau of Alcohol, Tobacco, and Firearms as set forth in 27 CFR 181, "Commerce In Explosives." Magazines shall be bullet-proof, rodent-resistant, weather-resistant, ventilated, and constructed to the standards of the Bureau of Alcohol, Tobacco, and Firearms, or the Institute of Makers of Explosives.

24.5.2 ***Magazine location.*** Explosive magazines shall be located in accordance with the State and local laws, and the proposed site shall be approved by the Contracting Officer's representative prior to location or construction. The magazines shall be located in accordance with appendix AA, Table of Distances for Storage of Explosives. Contractor and/or Government offices, shops, etc., are to be considered inhabited buildings when determining magazine locations.

24.5.3 ***Detonators.*** Blasting caps, electric blasting caps, detonating primers, and primed cartridges shall not be stored in the same magazine with other explosives or blasting agents. Detonator magazines shall be located at least 100 feet, if unbarricaded, and 50 feet, if barricaded, from magazines containing other explosives or blasting agents.

24.5.4 ***Combustible materials.*** Smoking and open flame shall not be permitted within 100 feet of storage magazines. Vegetation and combustible material shall be removed for a distance of at least 25 feet from all magazines.

24.5.5 ***Security.*** Magazines shall be kept securely locked at all times except for inspection or the movement of explosives. An inventory shall be maintained of all storage and withdrawal of explosives.

24.5.6 ***Posting.*** Areas around magazines shall be posted with **EXPLOSIVES** signs, located so a bullet passing through the sign will not strike a magazine.

24.5.7 ***Storage.*** Explosives shall be stored only in their original containers. Containers of explosives shall be stored with the top side up as designated on the container. The oldest stock of explosives shall be used first.

24.5.8 ***Maintenance.*** Debris and combustible material shall be promptly removed from magazines. When magazine floors become stained with nitroglycerin, they shall be cleaned with a stiff broom or brush and a fresh solution of one-half gallon of water, one-half gallon of wood alcohol, and two pounds of sulphide of sodium.

24.5.9 ***Transfer in and out.*** Provision shall be made for the safe transfer of explosives in and out of magazines, including provision for ramps or walkways as necessary.

24.5.10 ***Storage underground.*** Permanent storage of explosives underground is prohibited, and temporary storage shall comply with the following requirements:

a. Powder cars. Temporary storage shall be restricted to limited supplies stored in specially designed powder cars located at least 1,000 feet from the face or blasting area. Transformers, storage of flammable materials, welding, open flame, smoking, and other ignition sources shall not be permitted within 100 feet of the powder car.

b. Posting and lighting. The storage area or siding shall be designated by a red light visible in all directions, and both ends of the powder car shall be posted with a luminous sign, stating **EXPLOSIVES - NO SMOKING, FLAME, OR WELDING WITHIN 100 FEET.**

c. Protection. The powder car shall be located and/or barricaded to protect it from damage. Siding or car-passes when used for temporary storage shall be designed to protect the powder car from accidental entry by other cars, and to prevent accidental entry of the powder car to the main line. The protective devices installed shall be subject to approval of both the Contracting Officer and the State entity having jurisdiction.

24.6 HANDLING OF EXPLOSIVES

24.6.1 ***Requirement.*** Explosives shall be handled carefully, and shall not be dropped, thrown, or slid. Detonators, primers, and other explosives shall be carried in separate containers when transported manually; and when not in their original containers, shall be placed in a suitable nonmetallic container for manual transportation.

24.6.2 ***Removal from containers.*** Explosives shall be removed from original containers only as needed for immediate use. Such containers shall be opened only by means of nonsparking tools or devices. Empty containers and packing shall be promptly burned in an approved location or disposed of in accordance with the manufacturer's recommendations.

24.7 LOADING EXPLOSIVES AND BLASTING AGENTS

24.7.1 ***Planning***. Excavation shall be planned and scheduled in order that drilling and loading operations will not conflict. Loading shall not be permitted within 50 feet of drilling operations.

24.7.2 ***Loading areas***. Boreholes shall be made ready, and equipment and tools not used for loading shall be removed from the area before the explosives are delivered to the site. In major excavation operations, the loading areas shall be isolated by appropriate signs and/or temporary barricades to prohibit access by unauthorized persons.

24.7.3 ***Boreholes***. Boreholes shall be large enough to permit loading of cartridges and explosives without forcing. Priming, loading, tamping, and firing shall be carried on as promptly as possible with a minimum of exposure to personnel.

24.7.4 ***Tamping***. Tamping shall be done only with wooden or plastic tamping poles without exposed metal parts. Nonsparking metal connectors may be used on jointed poles. Cartridges shall be seated by even, steady pressure and primers shall not be tamped.

24.7.5 ***Priming***. The manufacturer's recommendations shall be followed in priming cartridges. Primers shall be made up only at the loading area, and in quantities limited to the number required for a single round of blasting (underground exception - subsection 24.4).

24.7.6 ***Stemming.*** All blast holes in open work shall be stemmed with noncombustible material to the collar or to a point which will confine the charge.

24.7.7 ***Extraneous electricity.*** Electric conductors, electric equipment, and all sources of ignition shall be prohibited in or adjacent to the loading area. Where stray currents are suspected, the area shall be thoroughly checked out with suitable instruments. If the elimination of stray currents is not possible, electric detonators, delays, and caps shall not be used or permitted in the area.

24.7.8 ***Shunts.*** The manufacturer's shunt shall not be removed from the cap leg wires until loading is completed and the cap is connected into the blasting circuit.

24.7.9 ***Springing holes.*** A bore hole shall not be sprung when it is near a loaded hole. Dry cell batteries shall not be used for springing holes.

24.7.10 ***Blasting mats.*** Where blasting may expose persons or property to injury or damage, blasting mats shall be used to cover the charges. When used, care shall be used to protect the blasting circuits, and the circuits shall not be permitted to contact steel mats.

24.7.11 ***Loading and shooting.*** Loaded holes shall not be left unattended or unprotected. If possible, all holes loaded during a shift shall be fired on the same shift. In the event it is necessary to delay firing due to an emergency, the area shall be isolated and watchmen posted to prevent entry to the area.

24.7.12 ***Pneumatic loading systems.*** Due to the hazards from static electricity and stray currents associated with pneumatically loading boreholes with blasting agents, the following precautions shall be taken.

a. Only approved pneumatic loaders shall be used.

b. The entire system, including placers, valves, and loading hose, shall be effectively grounded and bonded. In tunnels and shafts, the grounding shall be at the face, and piping and rails shall not be used to ground the system.

c. Checks shall be conducted, following installation of the ground, with an approved meter to ensure that the resistance is within safe limits.

d. Loading hoses shall be of an approved, nonsparking semiconductive material designed to maintain static electricity with safe limits.

24.7.13 ***Underground use of blasting agents.*** Prior to the use of blasting agents underground, the proposed method of loading and the loading equipment shall be inspected by a powder technician representing the explosive manufacturer or supplier. Written evidence of such inspection and approval of the system shall be submitted to the Contracting Officer.

24.8 WIRING OPERATIONS

24.8.1 *Firing devices.* All blasts shall be fired electrically with an electric blasting machine, properly designed and installed power source; or by a single safety fuse with the fuse cap, properly crimped thereto, when the presence or threat of stray currents is known or assumed to be present. Cap and fuse firing shall not be used underground or in the excavation of shafts. Electric blasting caps shall not be used within 500 feet of energized high-voltage lines or facilities.

24.8.2 ***Wiring procedure.*** The manufacturer's shunt shall not be removed from the cap leg wires until the cap is connected to the lead lines or to another cap in preparation for the assembly of two or more caps into a single series. When two or more series of caps are to be fired as a series-parallel system, the caps in each series shall be the same in number (quantity, not delay periods) and each series shall be separately tested with a galvanometer to: (1) ensure that the series is complete, and (2) ensure that each series has the same resistance and that the resistance is as close to the calculated resistance for the series. If the first reading indicates an incomplete circuit, the fault shall be located and corrected. If the second reading indicates a higher or lower resistance than calculated, the situation shall be corrected prior to final hookup and firing.

24.8.3 ***Electric caps and delays.*** All caps and delays in a shot shall be of the same manufacture and the number in a circuit shall not exceed the capacity of the blasting machine or power source.

24.8.4 ***Galvanometer testing.*** The following tests shall be made with an approved blasting galvanometer during all wiring operations. (a) The circuit, including all caps, shall be tested before being connected to the firing line. (b) The firing line shall be checked before being connected to the blasting machine or power source.

24.8.5 ***Firing lines.*** Firing lines shall be of sufficient current-carrying capacity, and not smaller than No. 14 B and S gage solid copper wire, or No. 12 B and S gage solid aluminum. The firing line shall not be connected to the blasting machine or power source until the wiring has been completed and tested, and the blast area cleared. A power circuit used for firing electric blasting caps shall not be grounded.

24.8.6 ***Connecting and lead wires.*** Connecting and lead wires shall be insulated single solid wires of sufficient current-carrying capacity.

24.8.7 ***Power circuit.*** When using a power circuit for firing, the firing switch shall be locked in the "OFF" (open) position at all times, except when firing. It shall be designed so that the firing lines to the cap circuit are automatically short-circuited when the switch is in the "OFF" position. Keys to the firing switch shall be entrusted only to the blaster. In underground operations, there shall be a "lightning" gap of at least 5 feet in the firing circuit, located between the firing switch and the source of power. The gap shall be bridged with a flexible jumper cord just prior to firing the blast.

24.9 FIRING

24.9.1 ***Preparation.*** Prior to connecting the firing line to the power source, all personnel in the danger area shall be notified of the blast and removed to a safe area. Satisfactory arrangements shall be made for evacuating the danger area and ensuring that no one enters the area prior to the blast.

24.9.2 ***Responsibility.*** The blaster shall be in charge of the blasting machine or firing switch, and he shall connect the firing line to the firing device. All connections shall be made from the cap circuit back to the firing device, and the firing line shall remain shorted until connected to the firing device immediately prior to firing.

24.9.3 ***Blasting signal.*** The following blasting signal shall be sounded on a clearly audible whistle before each blast:

> **Blasting warning:** a 1-minute series of long blasts 5 minutes prior to the blast signal.

Blast signal: a series of short blasts 1 minute prior to the shot.

All clear: a prolonged blast following inspection of the blast area.

24.9.4 ***Posting blasting signals.*** Blasting signals shall be posted at all access points, and prior to each shot, competent flagmen shall be posted at all access points to the danger area.

24.9.5 ***Disconnecting.*** Immediately following the blast, the firing line shall be disconnected from the firing power source or blasting machine, and shunted. Firing switches shall be locked open.

24.10 INSPECTION FOLLOWING A BLAST

24.10.1 ***All blasts.*** Prior to the all clear signal, a thorough inspection shall be made by the blaster to determine if all charges have been fired. Wires shall be carefully checked and a search made for unexploded charges.

24.10.2 ***Underground.*** In addition to the previously listed requirements, the heading shall be checked and tested for adequate ventilation and safe concentrations of dusts, toxic vapors, and gases. Also, prior to permitting personnel in the heading, the face shall be scaled and made safe.

24.10.3 ***All clear signal.*** The all clear signal shall be sounded only after the inspection of the area has been satisfactorily completed.

24.11 MISFIRES

24.11.1 ***Requirement.*** If a misfire is suspected or found, all personnel except the blaster and employees necessary to handle the misfire shall be kept out of the danger area. No work shall be done in the danger area except that necessary to remove the hazard of the misfire.

24.11.2 ***Refiring.*** If broken wires or faulty connections are determined as the cause, repairs shall be made, the firing line reconnected, and an attempt made to fire the charge. Prior to removing explosives from a borehole, a new primer shall be placed in the hole and an attempt made to fire the charge. Any stemming shall be floated out with water.

24.11.3 ***Removal of explosives.*** This procedure shall be the last resort and performed only when refiring has failed or when refiring would present a hazard. Explosives may be removed by washing out with water or if the misfire is under water, blown out with air.

24.11.4 ***Work restrictions.*** No drilling, digging, or picking shall be permitted until all missed holes have been detonated or the explosive removed, and the blaster has approved that work can proceed.

24.12 USE OF SAFETY FUSE

24.12.1 ***Requirement.*** Safety fuses shall be used only where sources of extraneous electricity make the use of electric caps dangerous. Use of damaged fuse or fuse with sharp kinks is forbidden.

24.12.2 ***Capping.*** Prior to capping a safety fuse, a short length shall be cut from the end to ensure a fresh-cut end in each blasting cap.

24.12.3 ***Crimper.*** Only cap crimpers of approved design shall be used for attaching blasting caps to safety fuse.

24.12.4 ***Length of fuse.*** The minimum length of safety fuse shall be as required by State law, but it shall not be less than 30 inches. Sufficient time shall be provided to permit the blaster to reach a place of safety.

24.12.5 ***Multiple cap and fuse use.*** At least two men shall be present when multiple cap fuse blasting is done by hand lighting methods. Not more than 12 fuses shall be lighted by each blaster when hand lighting devices are used.

24.12.6 ***Mudcapping.*** Cap and fuse shall not be used for firing mudcap charges unless the charges are separated sufficiently to prevent one charge from dislodging other shots in the blast.

24.13 USE OF DETONATING CORD

24.13.1 ***Care in use.*** Only detonating cord consistent with the type and physical condition of the bore hole, stemming, and the type of explosive shall be used. It shall be considered and handled in the same manner as other explosives.

24.13.2 ***Installation.*** The line of detonating cord extending out of a bore hole or from a charge shall be cut from the supply spool before loading the remainder of the hole or placing additional charges. All runs shall be free of loops, sharp kinks, or angles that take the cord back toward the oncoming line of detonation.

24.13.3 ***Connections.*** Detonating cord connections shall be competent and positive in accordance with approved and recommended methods. Knot-type or other cord to cord connections shall be made only with detonating cord in which the explosive core is dry. Connections shall be inspected before firing.

24.13.4 ***Use of delays.*** When detonating cord millisecond-delay connectors or short-interval-delay electric blasting caps are used with detonating cord, the manufacturer's recommendations shall be followed.

24.13.5 ***Connecting blasting caps.*** When connecting blasting caps to detonating cord, the cap shall be taped or otherwise attached securely along the side or the end of the cord, with the end of the cap containing the explosive pointed in the direction in which the detonation is to proceed.

24.13.6 ***Detonators.*** Detonators for firing the trunkline shall not be brought to the loading area nor attached to the detonating cord until everything else is in readiness for the blast.

24.14 UNDERWATER BLASTING

24.14.1 ***Supervision.*** A competent blaster shall conduct all blasting operations and no blast shall be fired without his approval.

24.14.2 ***Loading tubes.*** Loading tubes and casings of dissimilar metals shall not be used because of possible electrical transient current from galvanic action. Loading shall be done through nonsparking loading tubes when the use of tubes is necessary.

24.14.3 ***Blasting caps.*** Only water resistant blasting caps and detonating cord shall be used in underwater blasting operations.

24.14.4 ***Marking charges.*** When more than one charge is placed under water, a float device shall be attached to an element of each charge in such a manner that it will be released by the firing. Misfires shall be handled as set forth in subsection 24.11.

24.14.5 ***Blast warning.*** In addition to the standard audible blast warning, blasting flags shall be displayed.

24.14.6 ***Boats in area.*** No blast shall be fired while any vessel under way is within 1,500 feet of the blasting area. Those on board vessels moored or anchored within 1,500 feet shall be notified before the blast is fired.

24.14.7 ***Swimming and diving.*** No blast shall be fired when swimmers or divers are in the vicinity and exposed to injury from the blast.

Section 25
CONCRETE CONSTRUCTION AND FORMWORK

25.1 PLANT AND EQUIPMENT

25.1.1 ***General.*** In addition to the specific requirements of this subsection, the design, operation, and maintenance of all equipment used in concrete construction shall comply with the requirements set forth in subsections 18.15, Conveyors and Related Equipment, and 19.9, Other Mechanized Construction Equipment Standards, and all other applicable parts of this manual.

25.1.2 ***Batching and screening plants.*** Concrete batching plants, aggregate production plants, hoppers, bins, conveyors, and related equipment shall be designed and constructed with an adequate safety factor to eliminate danger of structural failure or collapse. Batching plants and aggregate plants shall be designed and equipped with dust collectors which will effectively control the dust and maintain the concentration of dust within the safe hygiene limits as specified in "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment," published by the American Conference of Governmental Industrial Hygienists.

25.1.3 ***Bulk storage bins.*** Bulk storage bins, containers, and silos shall have conical or tapered bottoms with a mechanical or pneumatic means of starting the flow of material.

25.1.4 ***Concrete mixers.*** One cubic yard or larger loading skips shall have protective guardrails installed on each side of the skip and shall be equipped with a mechanical device to clear the skip of material.

25.1.5 ***Bull floats.*** Handles on bull floats used where they can contact energized electrical conductors, shall be constructed of nonconductive material or insulated with a nonconductive sheath which will protect the operation from electrical shock.

25.1.6 ***Powered concrete trowels.*** Powered and rotating-type concrete troweling machines that are manually guided shall be equipped with a control switch that will automatically shut off the power whenever the operator removes his hands from the equipment handles.

25.1.7 ***Concrete buggies.*** Handles of concrete buggies shall not extend beyond the wheels on either side of the buggy.

25.1.8 ***Pumpcrete systems.*** Pumpcrete or similar systems using discharge pipes shall be equipped with pipe supports designed for a 100 percent or greater overload. Compressed-air hoses in such systems shall be provided with positive fail-safe joint connectors to prevent separation of sections when pressurized.

25.1.9 ***Concrete buckets.*** Concrete buckets equipped with hydraulic or pneumatically operated gates, shall have positive safety latches or similar safety devices installed to prevent premature or accidental dumping. The buckets shall be designed to prevent aggregate from accumulating on the top and sides of the bucket. Riding of concrete buckets is prohibited and vibrator crews shall not be permitted under buckets suspended from cranes or cableways.

25.1.10 ***Ready-mix trucks.*** The wheels of ready-mix trucks shall be blocked and the brakes set when discharging on a slope.

25.1.11 ***Tremies, elephant trunks, etc.*** Sections of tremies, elephant trunks, and similar conveyances shall be secured with wire rope in addition to the couplings or connectors.

25.2 REINFORCING STEEL

25.2.1 ***Guying.*** Reinforcing steel in walls, piers, columns, and similar structures shall be guyed and supported to prevent collapse.

25.2.2 ***Rigging.*** Bundles of reinforcing steel moved by crane or cableway shall be securely tied together to prevent slipping, and steel over 20 feet in length shall be handled by two-part slings.

25.2.3 ***Impalement.*** Employees shall not be permitted to work above vertically protruding reinforcing steel unless it has been covered to eliminate the hazard of impalement.

25.2.4 ***Safety belts.*** Employees working more than 6 feet above any adjacent working surfaces, placing and tying reinforcing steel in walls, piers, columns, etc., shall wear safety belts, or equivalent devices, as set forth in subsection 8.8.

25.2.5 ***Walkways.*** Reinforcing mats used as walkways shall be provided with planking to afford safe footing.

25.2.6 ***Prohibited uses.*** Reinforcing steel shall not be used as guy attachments at deadmen or other anchorage points and shall not be used for scaffolding hooks, stirrups, or as a load-bearing member of any lifting device.

25.3 SURFACE PREPARATION

25.3.1 ***Green cutting.*** Green cutting or wet sandblasting shall be performed with a protective head and face helmet equipped with a safety lens or fine mesh screen prohibiting entry of sand particles.

25.3.2 ***Sandblasting.*** Dry sandblasting shall be performed with airline respirators or air supplied hoods as set forth in subsection 8.4.

25.4 FORMWORK AND FALSEWORK

25.4.1 ***Design and erection.*** In addition to the specific requirements set forth in this section, the design and erection of formwork and falsework shall be in accordance with the pertinent provisions of Publication SP4, "Formwork for Concrete," pubished by the American Concrete Institute," and ANSI A10.9, "Safety Requirements for Concrete Construction and Masonry Work."

25.4.2 ***Safety factor.*** Formwork, falsework, structural shoring, and bracing shall be designed, erected, braced, and maintained so that it will safely support all vertical and lateral loads that might be applied until such loads can be supported by the structure. The minimum safety factors as specified in ANSI A10.9 shall be incorporated in the design and erection of all framework, shoring, falsework, and formwork accessories.

25.4.3 ***Construction loads.*** Imposition of any construction loads on the partially completed structures shall not be permitted unless such loading has been considered in the design.

25.4.4 ***Drawings and plans.*** Formwork and shoring shall be designed by a professional engineer or a qualified form designer familiar with the design requirements referenced in paragraphs 25.4.1 and 25.4.2. Drawings or plans showing the jack layout, formwork, shoring, working decks, and scaffolding shall be available at the jobsite.

25.4.5 ***Form anchors.*** Form anchors which support forms and scaffolding shall be designed with a minimum safety factor of three. No load shall be imposed on form anchors or concrete anchorages until the concrete has been allowed to set the minimum periods of time set forth in paragraph 25.10.4. Form sections supported by form anchors shall not exceed 50 feet in length and shall be installed in such manner that no impact loading, resulting from a form or anchorage failure, can be transferred to an adjacent section.

25.4.6 ***Housekeeping.*** In all areas in which persons are required to work or pass, stripped forms and shoring shall be removed and stockpiled promptly after stripping. Protruding nails, wire ties, and other accessories not required for subsequent work, shall be pulled, cut, or other measures taken to remove the hazard.

25.5 VERTICAL SHORING

25.5.1 ***Additional loading.*** when temporary storage of reinforcing rods, material, or equipment on the top of formwork becomes necessary, these areas shall be strengthened to support the additional loading.

25.5.2 ***Sills.*** Sills used in shoring shall be sound, rigid, and capable of carrying the maximum intended load.

25.5.3 ***Shoring equipment.*** All shoring equipment shall be inspected prior to erection to determine that it is as specified in the shoring layout. Equipment found to be damaged shall not be used for shoring.

25.5.4 ***Inspection.*** Erected shoring equipment shall be inspected immediately prior to, during, and immediately after the placement of concrete. Any shoring equipment found to be damaged or weakened shall be immediately reinforced or reshored.

25.5.5 ***Reshoring.*** Reshoring shall be provided when necessary to safely support slabs and beams after stripping or where such structures are subjected to superimposed loads.

25.5.6 ***Removal of shoring.*** Removal of shoring equipment shall not be undertaken until inspected and approved by a qualified engineer or supervisor. Removal shall be planned so that shoring equipment still in place is not overloaded.

25.6 TUBULAR WELDED FRAME SHORING

25.6.1 ***Safe loading.*** Metal tubular frames used for shoring shall not be loaded beyond the safe working load recommended by the manufacturer.

25.6.2 ***Condition.*** Locking devices on frames and braces shall be in good working order; coupling pins shall aline the frame or panel legs; pivoted cross braces shall have their center pivot in place; and all components shall be in good serviceable condition. Faulty or damaged parts and components shall be promptly repaired or replaced.

25.6.3 ***Inspection.*** Following erection, a thorough inspection shall be made to ensure that: (1) spacing between towers and cross brace spacing does not exceed that shown on the layout, and that all locking devices are in the closed position, (2) the devices for attaching the external lateral stability bracing are securely fastened to the legs of the shoring frames, and (3) baseplates, shore heads, extension devices, or adjustment screws are in firm contact with the footing sill and the form.

25.7 VERTICAL SLIP FORMS

25.7.1 ***Design and supervision.*** All vertical slip forms shall be designed by a registered professional engineer experienced in slip form design. Drawings prepared by the engineer showing the jack layout, anchorages, formwork, scaffolding, etc., together with installation, jacking, and leveling instructions shall be available at the jobsite and followed. The installation movement and leveling of the forms shall be carried out under the immediate supervision of a person or persons experienced in slip form operation.

25.7.2 ***Jack supports.*** The steel rods or pipe on which the jacks climb or by which the forms are lifted shall be specifically designed for that purpose. Such supports, when secured by form anchors, shall utilize at least two independent form anchors separated a minimum of 5 feet vertically.

25.7.3 ***Vertical loading.*** Jacks and vertical supports shall be positioned so that the vertical loads are distributed equally and do not exceed the capacity of the jacks.

25.7.4 ***Line and plumb.*** During jacking operations, the form structure shall be maintained in line and plumb.

25.7.5 ***Lifting.*** Lifting shall proceed steadily and evenly and shall not exceed the predetermined safe rate of lift.

25.7.6 ***Bracing.*** Lateral and diagonal bracing of the forms shall be provided to prevent excessive distortion of the structure during the jacking operation.

25.7.7 ***Holding devices.*** The jacks or other lifting devices shall be provided with mechanical dogs and other automatic holding devices to provide protection in event of failure of the power supply or the lifting mechanism.

25.7.8 ***Scaffolding and platforms.*** Vertical lift forms shall be provided with scaffolding or work platforms, installed in compliance with paragraph 25.4.5, completely encircling the area of placement.

25.8 TUBE AND COUPLER SHORING

25.8.1 ***Design.*** Tube and coupler shoring shall be designed for the maximum intended loading with a minimum safety factor of 2.5.

25.8.2 ***Couplers.*** Couplers (clamps) shall be of a structural-type metal such as drop-forged steel, mallable iron, or structural grade aluminum. Gray cast iron shall not be used. Couplers that are deformed, broken, or have defective or missing threads or bolts shall not be used.

25.8.3 ***Inspection.*** Following erection, a thorough inspection shall be made to ensure that:

a. The shoring has been erected as shown on the layout drawings.

b. The spacing between posts does not exceed that shown on the layout.

c. All interlocking tubular members and couplings are properly installed and tightened.

d. All baseplates, shore heads, extension devices, or adjustment screws are in firm contact with the footing sill and the form material, and snug against the legs of the frames.

25.9 SINGLE-POST SHORES

25.9.1 ***Design.*** Single-post shoring layouts shall provide for the maximum intended loading with a minimum safety factor of three. When single-post shores are to be used in more than one tier, they shall be designed and inspected by a licensed structural engineer.

25.9.2 ***Bracing.*** Single-post shores shall be horizontally braced in both the longitudinal and transverse directions, and shall also be braced diagonally. The bracing shall be installed as the shores are being erected.

25.9.3 ***Inspection.*** Single-post shores and adjusting devices shall be inspected before use. Fabricated shores and adjusting devices shall not be used if heavily rusted, bent, dented, rewelded, damaged, or defective in any manner. Timber shores and timber components of fabricated shores shall not be used if split, knotted, broken, or otherwise structurally defective.

25.9.4 ***Baseplates and shore heads.*** Baseplates and shore heads of single-post shores shall be in form contact with the footing sill and the form materials.

25.9.5 ***Angled formwork.*** When formwork is at an angle or sloping, or when the shored surface is sloping, the shoring shall be specially designed for such loading.

25.9.6 ***Adjustment.*** Adjustment of single-post shores shall not be made after concrete is in place.

25.10 RELEASING AND MOVING FORMS

25.10.1 ***Lifting.*** Forms shall be securely attached to wire rope slings, having a minimum safety factor of eight, when raised or moved by crane, cableway, A-frame, or similar mechanical lifting device. Panels and form sections shall be equipped with hoisting brackets for attachment of slings. Loose tools and materials shall be removed prior to moving the forms.

25.10.2 ***Riding forms.*** Employees shall not be permitted to ride on forms or form scaffolding being raised or moved, with the exception of vertical slip forms.

25.10.3 ***Releasing.*** Vertical and overhead forms shall not be released until adequately braced or secured. Workmen at lower levels, exposed to falling materials, shall be removed to a safe area prior to release and moving of forms.

25.10.4 ***Form removal.*** Forms shall not be removed until the concrete has sufficiently set to allow the safe removal of the forms, shoring, and bracing. When not specifically stated in the contract specifications, under normal conditions, form supports shall remain in place for at least the following periods of time following concrete placement:

Arch Centers	14 days
Centering Under Beams	14 days
Floor Slabs	7 days
Walls	12-24 hours
Columns	12-24 hours
Sides of Beams	12-24 hours

The periods indicated represent the cumulative number of hours or days, not necessarily consecutive, during which the temperature of the concrete is above 50 °F.

25.11 FORM SCAFFOLDING

25.11.1 ***Requirement.*** Forms intended for use where there is a free fall over 6 feet shall be provided with scaffolding and guardrails, or the employees working on such forms shall be required to use safety belts and lanyards. The latter shall be permitted only when specifically approved by the Contracting Officer's representative.

25.11.2 ***Design and installation.*** Form scaffolding shall be designed and installed in accordance with the requirements set forth in subsection 13.21.

Section 26

STEEL ERECTION

26.1 PERMANENT FLOORING

26.1.1 ***Installation.*** Permanent floors shall be installed as the erection of structural members progresses, and there shall not be more than eight stories between the erection floor and the uppermost permanent floor except where the structural integrity is maintained as a result of the design.

26.1.2 ***Bolting and welding.*** There shall not be more than four floors or 48 feet of unfinished bolting or welding above the structure foundation or the uppermost permanently secured floor.

26.2 TEMPORARY FLOORING

26.2.1 ***Planking.*** The derrick or erection floor shall be solidly planked or decked over its entire surface except for access openings. Planking, or decking, shall be of sufficient thickness and strength to support the working load. In no event shall planking be less than 2 inches thick, full dimension undressed, and it shall be laid flush and secured to prevent movement.

26.2.2 ***Skeleton steel erection.*** Where skeleton steel erection is being done, a tightly planked and substantial floor shall be maintained within two stories or 30 feet, whichever is less, below and directly under that portion of each tier of beams on which any work is being performed; except when gathering and stacking temporary floor planks on a lower floor in preparation for transferring such planks for use on an upper floor. When installation of such a floor is not practicable, safety nets shall be installed.

26.2.3 ***Safety nets.*** On bridges, buildings or structures not adaptable to temporary floors, and where scaffolds are not used, safety nets shall be installed when the potential fall distance exceeds 25 feet. Safety nets shall be fabricated, installed, tested, and maintained as set forth in subsection 8.10.

26.2.4 ***Temporary planking removal.*** Temporary planking shall be removed successively, working toward the last panel of temporary floor, so the work is done from the planked floor. Employees removing planks from the last panel shall be protected by safety belts with safety lines attached to a catenary line or other substantial anchorage.

26.3 OTHER FLOORING

26.3.1 ***Double-wood floors.*** In erection of buildings having double-wood floor construction, the rough flooring shall be completed as the construction progresses, including the tier below the one on which the floor joists are being installed.

26.3.2 ***Single-wood floor.*** For single-wood floors or other flooring systems, the floor immediately below the story where the floor joists are being installed shall be kept planked or decked over.

26.4 STRUCTURAL STEEL ERECTION

26.4.1 ***Solid-web structural members.*** In placing solid-web structural members, the hoisting line shall not be released until the member is secured with not less than two bolts or 10 percent of the bolts, whichever is greater, at each connection. The bolts shall be drawn up wrench tight.

26.4.2 ***Open-web joists.*** Open-web steel joists shall not be placed on any structural steel framework until such framework is permanently bolted, riveted, or welded.

26.4.3 ***Bar joists.*** In steel framing, where bar joists are used and the columns are not framed in at least two directions with structural steel members, a bar joist shall be field bolted at the columns to provide lateral stability.

26.4.4 ***Long-span joists.*** Where long-span joists or trusses, 40 feet or longer, are used, a center row of bolted bridging shall be installed prior to slacking of the hoisting line in order to provide lateral stability.

26.4.5 ***Securing structural members.*** Each structural steel member shall be securely bolted or fastened into position before the loadline is released. When setting steel trusses, they shall be temporarily cross braced until permanent bracing is installed.

26.4.6 ***Taglines.*** A tagline or guide rope shall be used on all hoisted loads where personnel are exposed to the swing of the load.

26.4.7 ***Temporary support.*** Structural and reinforcing steel for walls, piers, columns, and similar vertical structures shall be guyed and supported to prevent collapse.

26.5 PLUMBING-UP

26.5.1 ***Connections.*** Connections of the equipment used in plumbing-up shall be properly secured. Turnbuckles shall be secured to prevent unwinding when under stress.

26.5.2 ***Guys.*** Plumbing-up guys and related equipment shall be positioned so that employees can work on the connection points. The plumbing-up guys shall be removed only under the supervision of a competent person.

26.6 BOLTING

26.6.1 ***Drift pins.*** When bolts or drift pins are being knocked out, a means shall be provided to keep them from falling.

26.6.2 ***Impact wrenches.*** Impact wrenches shall be equipped with a locking device for retaining the socket.

26.6.3 ***Containers.*** Containers shall be provided for storing and carrying bolts, drift pins, and rivets; and they shall be secured against accidental displacement when aloft.

26.7 RIVETING

26.7.1 ***Fire protection.*** Riveting shall not be done in the vicinity of combustible material unless fire extinguishers or hose lines are readily available to extinguish fires.

26.7.2 ***Riveting hammers.*** A safety wire shall be properly installed on the snap and on the handle of the pneumatic riveting hammer and shall be used at all times. The wire shall be not less than No. 9 (B&S gage) leaving the handle and annealed No. 14, or equivalent, on the snap.

26.7.3 ***Removing rivets.*** When rivet heads are knocked off or backed out, a means shall be provided to keep them from falling.

26.8 STEEL TRANSMISSION TOWERS

26.8.1 ***Requirement.*** Requirements governing the assembly and erection of steel transmission towers are set forth in section 27, Transmission and Distribution Line Construction.

Section 27
TRANSMISSION AND DISTRIBUTION LINE CONSTRUCTION

27.1 GENERAL

27.1.1 ***Application.*** As used in this section, the term "construction" includes the erection of new electric transmission and distribution lines and improvement of existing electric transmission and distribution lines and equipment.

27.1.2 ***Energized lines and equipment.*** Work on energized transmission and distribution lines and equipment is prohibited unless specifically approved in writing by the Contracting Officer. All lines and equipment in excess of 600 volts on which work is to be performed shall be deenergized in the manner set forth in this section, prior to starting work or permitting employees other than those engaged in clearance procedure to approach such lines and/or equipment. Work on energized lines or equipment in excess of 600 volts, when authorized in writing by the Contracting Officer, shall be performed in strict compliance with the applicable provisions and requirements set forth in Reclamation's "Power System Safety Standards."

27.1.3 ***Equipment operation.*** Operation and maintenance of equipment used in the construction of transmission and distribution lines shall comply with the requirements set forth in sections 18 and 19 of this manual, in addition to the specific requirements of this section. Operation of equipment near or adjacent to high-voltage lines shall conform to the requirements set forth in paragraph 12.9.4.

27.1.4 ***Minimum distances.*** No employee shall be permitted to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in table 27-1.

Table 27-1.—*Minimum distances from energized components*

Voltage range (phase-to-phase)	Minimum distance (clearance)
2.1 through 69 kV	5 ft
70 through 230 kV	8 ft
231 through 345 kV	10 ft
346 through 500 kV	15 ft
501 through 765 kV	20 ft

27.1.5 ***Preliminary checks.*** Existing conditions shall be determined prior to starting work, by a thorough inspection of the site and tests if necessary. Such conditions shall include, but are not limited to, energized lines and equipment, conditions of poles and structures, and location of utilities. The owners or operators of all adjacent utilities shall be notified and a coordinated plan for protection of the utilities agreed upon. Electric equipment and lines shall be considered energized until determined to be de-energized by tests or other reliable means.

27.1.6 ***Responsibility.*** The contractor shall assign a competent supervisor the responsibility for ensuring full compliance with all provisions of this section.

27.2 DEENERGIZING LINES AND EQUIPMENT

27.2.1 ***Requirement.*** The particular sections of line or equipment to be deenergized shall be clearly identified and the owners and operators of the utility requested to deenergize and isolate it from all other sources of voltage. The following notification and assurance shall be obtained from the utility or operator.

a. All switches and disconnects through which electric energy may be supplied to the particular section of line or equipment have been "opened" and the line or equipment deenergized.

b. All switches and disconnects are plainly tagged indicating that men are at work. Where the design of such switches and disconnects permit, they shall be locked "open."

27.2.2 ***Protective grounds.*** After assurance has been given that the switches and disconnects have been opened, locked, and tagged, visual inspection or tests shall be made by the contractor to ensure that the equipment or lines have been deenergized. When the deenergized circuit is not visibly open or visibly locked out, as viewed from the work area, protective grounds shall be applied using hot sticks of sufficient insulating capacity. On deenergized lines the protective grounds shall be installed on both sides of the work area.

27.2.3 ***Guards or barriers.*** Guards or barriers shall be erected as necessary to protect employees from adjacent energized lines or equipment.

27.2.4 ***Reenergizing.*** Following completion of the work, the clearance tags shall not be removed and the lines or equipment reenergized until all employees are in the clear and the protective grounds are removed.

27.3 MATERIAL HANDLING

27.3.1 ***Unloading.*** Prior to unloading poles, crossarms, tower sections, and similar materials, the load shall be thoroughly examined to determine if the load has shifted, binders or stakes have broken, or if the load is otherwise dangerous to unload. In loading or unloading poles from trailers or flatcars, all work shall be carried out from the ends of the load, with the workmen remaining in the clear in event the load shifts. Binders shall be slackened by use of a winch line, to maintain control of the poles as they roll from the car or trailer.

27.3.2 ***Pole hauling.*** Pole trailers shall be equipped to meet the vehicle regulations of the State having jurisdiction. All loads shall be secured to prevent displacement, and a red flag shall be displayed on the trailing end of the longest pole. At night, an illuminated warning device shall be used. Precaution shall be exercised to prevent blocking roads or endangering other traffic.

27.3.3 ***Storage.*** Poles, steel, tower sections, and heavy materials and equipment shall be stacked on firm foundations, and sufficient lagging used to prevent displacement. Materials and equipment handled by hoisting equipment shall not be stored under energized buses or lines.

27.3.4 ***Taglines.*** Taglines shall be used to control poles and tower sections being handled by hoisting equipment.

27.3.5 ***Framing.*** During framing operations, employees shall not work under a pole or structure suspended from a crane, A-frame, or other hoisting equipment, unless the pole or structure is adequately supported from the ground.

27.4 GROUNDING PROCEDURE

27.4.1 ***Requirement.*** All conductors and equipment shall be treated as energized until tested or otherwise determined to be deenergized, or until grounded. On new construction, the new lines and equipment may be considered deenergized and worked as such only when grounded for the specific conditions and in the manner as set forth in this section.

27.4.2 ***Ground leads.*** Ground leads attached to either a tower ground or driven ground shall be capable of conducting the anticipated fault current and shall have a minimum conductance equal to No. 1/0 AWG copper. Protective grounding cables shall be installed so that all phases of lines and equipment are visibly and effectively bonded together in a multiphase "short" and connected to ground at one or more points.

27.4.3 ***Grounding electrodes.*** When grounding electrodes are used, such electrodes shall have a resistance to ground low enough to remove the danger of harm to personnel or to permit prompt operation of protective devices.

27.4.4 ***Tower clamps.*** Grounding to towers shall be made with tower clamps capable of conducting the anticipated fault current.

27.4.5 ***Testing.*** A hot stick, "noisy tester," or similar approved device of sufficient insulating capacity shall be used to verify the circuit is deenergized prior to placement of grounds.

27.4.6 ***Placing and removal.*** When attaching grounds, the ground end shall be attached first, and the other end attached by means of hot sticks of sufficient insulating capacity. When removing grounds, the grounding device shall first be removed from the line or equipment using a hot stock of sufficient insulating capacity. Use of grounding chains is prohibited.

27.5 FOOTING CONSTRUCTION

27.5.1 ***Footing excavation.*** Augered holes shall be covered to prevent persons or livestock from falling into the excavation. Excavation for pad- and piling-type footings shall be protected by fencing as warranted by conditions, e.g., presence of livestock, children, and the depth and stability of the banks. No one shall be permitted to enter an auger-type footing excavation.

27.5.2 ***Shoring and ladders.*** When there is a question as to the stability of excavated slopes for pad type or pile type footings, shoring shall be installed or the excavation sloped to the angle of repose. Ladders shall be provided for access to footing excavation.

27.5.3 ***Heavy equipment.*** Safe equipment access, including provision for grading, leveling, and shoring, as necessary, shall be provided in order to ensure safe operation of mobile equipment. Spotters shall direct the backing of mobile equipment, and the wheels shall be blocked on slopes. Employees shall be removed from the excavated foundations when heavy equipment is being maneuvered into position.

27.5.4 ***Concrete placement.*** Platforms shall be provided on pad-or pile-type footings for formwork and concrete placement. Refer to section 25, Concrete Construction and Formwork.

27.6 TOWER ASSEMBLY AND ERECTION (Timber or Metal)

27.6.1 ***Equipment.*** Hoisting and rigging equipment shall be regularly inspected and maintained in safe operating condition. Cranes used for erection shall be set on firm, level foundations. When cranes are equipped with outriggers, they shall be used during assembly and erection operations.

27.6.2 ***Tower assembly.*** Tower assembly shall be performed with a minimum exposure of employees to falling objects when working at two or more levels.

Members and sections of towers being assembled shall be adequately guyed and/or supported during assembly.

27.6.3 ***Tower erection.*** No one shall be permitted under a tower which is in the process of erection or assembly, except as may be required to guide and secure the section being set. Following positioning of a tower section, the loadline shall not be detached until the section is securely bolted at each leg junction. Erection shall be carried out under the continuous direct supervision of a contractor supervisor.

27.6.4 ***Taglines.*** Taglines shall be used to maintain control of sections being raised and positioned, except where the use of such lines would create a greater hazard.

27.6.5 ***Adverse weather.*** Except during emergency restoration operations, erection shall be discontinued in the event of high wind or other adverse weather conditions which would make the work hazardous.

27.6.6 ***Moving erection equipment.*** Flagmen shall be used when crossing highways and railroads. A flagman or signalman shall be used to ensure that the required clearance is maintained in moving equipment under or near energized lines.

27.6.7 ***Energized lines.*** Tower erection, using hoisting equipment adjacent to energized distribution or transmission lines, shall be subject to the following requirements:

a. Equipment operation. Equipment operation shall conform to the requirements set forth in paragraph 12.9.4.

b. Reclosures. Erection shall not be permitted until the automatic reclosures have been made inoperative and a "hot line order" placed on the adjacent energized transmission line. The contractor shall be responsible for securing hot line orders from the utility company or other agency operating the adjacent line. The Contracting Officer's representative shall be promptly informed of all such hot line orders. Hot line orders on federally owned transmission lines shall be secured through the Contracting Officer's representative.

27.7 STRINGING OPERATIONS

27.7.1 ***Contractor's plan.*** Prior to starting stringing operations, the contractor shall submit a detailed plan of operation to the Contracting Officer's representative for review and approval. The plan shall include a description of the stringing method, the type and description of stringing equipment, grounding devices, crossover methods to be used, and clearances required.

27.7.2 ***Terminal grounding.*** The conductors being strung shall be grounded at each terminal or takeoff structure using hot-stick grounds, and the terminal jumpers shall not be installed. All aerial cleanup shall be completed under these grounding conditions, and no further aerial work performed following removal of the terminal grounds.

27.7.3 ***General stringing requirements.*** The following requirements shall apply to all stringing operations as applicable.

a. Hardware. Catch-off anchors, rigging, and hoists shall be of ample capacity to ensure against loss of lines. Stringing lines, pulling lines, and all load-bearing hardware and accessories shall have a minimum safety factor of five times the anticipated pulling tension. Pulling lines, hardware, and accessories shall be inspected regularly and replaced when damaged or when dependability is doubtful.

b. Reel handling equipment. Reel handling equipment, including pulling and braking machines, shall have ample capacity, operate smoothly, and be leveled and alined in accordance with the manufacturer's operating instructions. Reels shall be securely attached to the reel jacks and no one shall be permitted immediately in front of the reels while pulling. Reel tenders or operators shall remain at the controls at all times when pulling is in progress. Pulling speeds shall not exceed the manufacturer's recommendations.

c. Communications. Reliable communications between the reel tender and pulling machine operator shall be provided. Use of radio communication is required for tension stringing and recommended for layout and back stringing operations.

d. Conductor grips. Conductor grips shall not be used on wire rope unless designed for such application.

e. Hazard areas. While the conductor or pulling line is being pulled, or in motion, employees shall not be permitted under the lines, nor on the towers.

f. Handlines. Handlines shall have a minimum safety factor of three, and hoisted materials shall be rigged to prevent dropping.

g. Safety belts. Linemen's body belts and straps, as described in paragraph 8.9.2, shall be worn by employees working in structures and on aerial ladders.

h. Ladders. Ladders used in structures shall be positively secured by a safety device to prevent accidental displacement.

i. Lightning. Stringing and clipping operations shall be discontinued when lightning is present or imminent in the vicinity.

j. Adverse weather. Work on or in structures shall be discontinued when high winds, icing, or other conditions make work hazardous.

k. Tools. Handlines and tool bags shall be provided and used. Tools and materials shall not be thrown or dropped from structures or poles.

l. Snubbing off. Each pull shall be snubbed off or dead ended before subsequent pulls are started.

27.7.4 ***Clipping.*** Clipping crews shall have at least two structures clipped in between them and the conductor or overhead ground line being sagged. Clipping crews shall work between grounds at all times. The grounds shall remain in place until the conductors and overhead ground lines are clipped in and aerial work is completed.

27.7.5 ***Layout stringing.*** Conductors and overhead ground wires laid out under an energized line shall be securely tied down to prevent being pulled up into the energized line.

27.7.6 ***Tension and backstringing.*** When using the tension stringing or backstring method, all hot line, highway, and railroad crossings shall be attended during pulling operations. Each attendant shall be provided with a means, preferably radio, to stop the pulling operation immediately should trouble develop.

27.8 STRINGING OVER OR UNDER POWERLINES

27.8.1 ***Clearances and hot line orders.*** Prior to stringing over or under an existing powerline, the contractor shall inform the owner or utility company and request that the existing line be deenergized if possible. If the line is to be deenergized, the contractor shall complete arrangements for obtaining proper clearances, and grounding the deenergized line on both sides of the crossover. If the existing line is not to be deenergized and grounded, the contractor shall request that the automatic reclosures be made inoperative and a "hot line order" placed on the existing energized line. The Contracting Officer's representative shall be kept fully informed of all such clearances and hot line orders.

27.8.2 ***Energized powerlines.*** When crossing over or under energized conductors in excess of 600 volts, the conductors, subconductors, and overhead ground wires on the line under construction shall be grounded at the first tower structure on both sides of the energized line being crossed. Unless nonconductive, the pulling lines shall also be grounded during the pulling operation. The grounds shall remain intact until the conductors are clipped in.

27.8.3 ***Nets and guard structures.*** When crossing over energized conductors in excess of 600 volts, dry-rope nets suspended from guard structures shall be installed. Guard structures shall be constructed with crossarms and shall be firmly set and securely guyed. A plan showing the design and construction of the proposed guard structures shall be submitted for the Contracting Officer's authorized representative's review and approval prior to proceeding with the crossover stringing. Where literal application of this provision is impractical due to clearance restrictions, the net requirements can be waived by the Contracting Officer's Authorized Representative.

27.9 HIGHWAYS, RAILROADS, TELEPHONE, AND LOW-VOLTAGE LINES

27.9.1 ***Requirement.*** Substantially constructed guard structures shall be used in crossing over telephone lines, low-voltage lines, and railroads, highways, or roads where traffic cannot be stopped or detoured. The owner, utility, or authority having jurisdiction shall be notified in advance of making all such crossings.

27.10 STRINGING ADJACENT TO ENERGIZED LINES

27.10.1 ***Requirement.*** Unless a registered professional electrical engineer has made a competent and Bureau acceptable determination that dangerous induced-voltage buildups (particularly during switching and ground-fault conditions) cannot occur in lines being strung adjacent to, or paralleling existing energized transmission lines or facilities, the contractor will comply with the requirements of this and all other applicable subsections.

27.10.2 ***Stringing plan.*** A stringing plan, including drawings, description of stringing equipment, bonding and grounding measures, and other safety measures to be taken, shall be submitted for the Contracting Officer's review and approval.

27.10.3 ***Tension stringing.*** Only tension stringing, or comparable method which will preclude unintentional contact between the lines being pulled and any employee, shall be used.

27.10.4 ***Grounding and bonding.*** The following grounding and/or bonding requirements are considered minimal; compliance with these requirements is mandatory.

a. Pulling and tensioning equipment. Pulling and tensioning equipment shall be bonded and effectively grounded. At least two approved, driven grounds shall be used at both the pulling and tensioning setups. Also, an insulated platform and barriers shall be installed around all conductive parts of the pulling and tensioning equipment.

b. Moving grounds. Moving grounds shall be installed within 20 feet of the tensioning reel in order to ground each pulling line, conductor, subconductor, and overhead ground wire.

c. Tower grounds. Pulling lines, conductors, subconductors, and overhead ground wires shall be grounded at the first tower adjacent to both the tensioning and pulling setup during the stringing operation.

d. Deadend and catchoff points. Conductors, subconductors, and overhead ground wires shall be grounded with approved grounds at all deadend or catchoff points.

e. Splicing. An approved driven ground shall be located on each side, and within 10 feet of work areas where wires are being spliced at ground level. The two ends to be spliced shall be bonded to each other. Splicing shall be done from either an insulated platform or a conductive metallic grounding mat bonded to both driven grounds. An insulated walkway shall provide access to the grounding mat.

f. Intermittent grounds. Conductors, subconductors, and insulated overhead ground wires shall be grounded to the towers at intervals of 2 miles or less. These grounds shall be placed and removed with hot sticks, and shall not be removed until the last phase of cleanup.

g. Isolated and deadend towers. Conductors, subconductors, and overhead ground wires shall be grounded at all isolated towers where it is necessary to complete work on the line. Work on deadend towers shall require grounding of all deenergized lines. Grounds on isolated towers may be removed as soon as the work is completed, provided the line is not left open circuited at the isolated tower at which work is being performed.

h. Individual grounds. When performing work from the structures, clipping crews and all others working on conductors, subconductors, or overhead ground wires shall be protected by individual grounds installed at every work location.

27.10.5 ***Approved protective devices.*** Protective devices used in stringing adjacent to energized facilities shall meet the following criteria.

a. Moving grounds. Moving grounds shall exert constant pressure on the wire pulled, and not exceed 1 ohm resistance measured between the conductor and point of attachment of the ground lead to the tower or driven ground. They shall be securely attached to a tower structure or driven ground. They shall be designed with permanently lubricated-type bearings.

b. Approved driven grounds. Driven grounds shall be a flexible ground lead attached to a 5/8-inch-diameter or greater, 10-foot copperweld or galvanized-type rod, or equivalent. Ground rods shall be driven into the ground at least 8 feet.

c. Approved tower grounds. Tower grounds shall be hot-stick, clamp-type grounds with a flexible ground lead.

d. Approved-type ground leads. Ground leads shall be minimum No. 1/0 AWG flexible copper wire or equivalent.

e. Insulated platforms and barriers. Insulated platforms shall be constructed of 2-inch nominal dimension lumber supported on 4-inch nominal dimension sills, or of materials offering equivalent protection. At the pulling and tensioning setup, the insulated platform and rope barriers shall extend completely around the equipment and prevent anyone standing on the ground from contracting any conductive part of the equipment.

27.10.6 ***Additional safety measures.*** The safety requirements in this subsection may have to be implemented, dependent upon the induced voltage buildup and field conditions encountered. Such implementation to be considered by the contractor, may require the use of nonconductive pulling lines; bonding of the conductors, subconductors, overhead ground wires; pulling lines to the towers at shorter predetermined intervals; etc.

Section 28

STAGE CONSTRUCTION IN ENERGIZED SUBSTATIONS

28.1 GENERAL

28.1.1 ***Authorization, supervision, and inspection.*** No work shall be performed in an energized substation until authorization to proceed is obtained from the Contracting Officer's representative at the worksite. All work shall be performed under the immediate supervision of a qualified foreman.

28.1.2 ***Contractor responsibility.*** The contractor shall exercise extreme care and take necessary precautions for the safety of his employees and others in performing construction operations in energized substations. He also shall be responsible for performing his work in such a manner as not to endanger personnel, existing power equipment and facilities, or to cause interruption in electrical service.

28.1.3 ***Energized facilities.*** Work by contractor forces on energized buses, circuits, and other electrical equipment will not be required nor permitted unless specifically covered in the contract specifications. However, if a portion of the work to be done is in the immediate vicinity of energized sections of the substations, the contractor shall be responsible for securing information as to what facilities are energized, taking all necessary precautions for the safety of his personnel, and keeping his employees fully informed of the situation, including safe work limits.

28.1.4 ***Jurisdiction.*** The substations and the electrical equipment are subject at all times to Government standard operating procedures and regulations. These regulations require use of formal clearance procedures with provision for protective tagging and grounding of that portion of the equipment necessary to perform the work under contract. The regulations provide for "hot line orders" on energized circuits immediately adjacent to the work. Usually, provision is made to deenergize only those buses and circuits as necessary to accomplish the work. Such deenergization is ordinarily carried out on a progressive, preplanned basis, determined by the progress of construction. Also, certain operating facilities will be released only at prescheduled times during the day, such as offpeak periods, in order to maintain continuity of commercial electrical service. Under these conditions, it is essential that the contractor closely plan his operations to fully utilize time afforded by the clearance. He also shall supervise his operations in order that all necessary precautions are taken for the safety of his employees, the protection of existing facilities, and uninterrupted power.

28.2 CLEARANCES AND SPECIAL WORK PERMITS

28.2.1 *Clearances*. Clearances are required for deenergizing and isolating operating facilities for construction work. Where construction work is required close to energized circuits, hot line orders are required. Absolutely no work shall be done under these conditions until such clearances are secured and the contractor's representative secures a special work permit from the Contracting Officer's representative. Issuance of clearances, hot line orders, and special work permits are handled in accordance with the Bureau's Power O&M Bulletin No. 26, "Power System Clearance Procedure." The following procedure shall be followed in securing special work permits.

a. No work requiring an outage or hot line order shall be performed by the contractor without first securing a special work permit. In requesting a special work permit for a specific phase of work requiring a clearance or hot line order, the contractor shall make his request in writing. The request shall include a plan of operation indicating the work to be done, the sequence of operations, time he desires to start work, duration of work, description of equipment to be used, safety precautions to be taken, and type and location of barricades, warning signs, protective grounds and devices to be used in performing the work.

b. Following approval of the contractor's plan of operation, the representative of the Contracting Officer at the worksite will secure a clearance or a hot line order, as appropriate, from the power operations supervisor. He will, in turn, outline the work area to the contractor's onsite representative and then issue a special work permit authorizing the contractor to proceed with the work.

c. The special work permit will indicate the limits of the work area, restrictions, and conditions pertinent to the clearance or hot line order. The special work permit shall be signed by both the contractor's and the Contracting Officer's representatives at the jobsite, and a copy retained by both.

d. The contractor shall review the approved plan with his employees and his subcontractors before proceeding with the work, and as frequently thereafter as necessary to ensure that they have full knowledge of the plan of operation and the required safety precautions.

28.3 GROUNDING REQUIREMENTS

28.3.1 ***Requirement.*** All electrical circuits and equipment, normally operated in excess of 600 volts, shall be considered energized until disconnected from all sources of electrical energy, a clearance or special work order obtained, and the circuits and/or equipment properly grounded. If possible, the grounds shall be placed within sight of the workmen. Contractor representative holding the clearance or special work permit shall be personally responsible to ensure the proper placement and removal of the protective grounds.

28.3.2 ***Ground leads.*** For normal stage construction, ground leads shall be minimum 1/0 AWG extra-flexible copper or 3/0 AWG extra-flexible aluminum or equivalent. Normally, ground leads should not exceed 40 feet in length.

28.3.3 ***Testing.*** A hot-stock, "noisy tester," or similar approved device of sufficient insulating capacity shall be used to verify the fact that the circuit is deenergized prior to placement of grounds.

28.3.4 ***Placement and removal.*** Protective grounding cables shall be installed so that all phases of lines and equipment are visibly and effectively bonded together in a multiphase "short" and connected to ground at one or more points. Protective grounds shall be installed on both sides of the work area. When attaching grounds, the ground end shall be attached first, and the other end attached to the deenergized circuit by means of a hot-stick of sufficient insulating capacity. When removing grounds, the grounding clamp shall first be removed from the deenergized circuit using a hot-stick of sufficient insulating capacity. Use of single-phase grounds and grounding chains is prohibited.

28.4 RESTRICTED AREAS

28.4.1 ***Requirement.*** All areas of the substation other than the deenergized areas and access ways specifically set forth in the special work permit shall be considered restricted areas. No contractor employees shall enter a restricted area except under the immediate supervision of a contractor foreman following approval of a Bureau supervisor. All restricted areas shall be considered energized areas and the specific safety precautions to be taken when entering such areas shall be presented to the Bureau supervisor for approval prior to entry.

28.4.2 ***Barricades and signs.*** All designated work areas and access ways, as described in the special work permit, shall be isolated from the restricted areas by approved barricades and signs. The contractor shall furnish, erect, and maintain all such barricades and signs. They shall be erected prior to starting work in the designated work areas. The contractor shall be fully responsible for isolating the safe work areas and access ways and keeping his employees out of restricted and hazardous areas. Approved barricades and signs shall be as described in the following subparagraphs:

a. Approved barricades. Approved barricades shall be constructed of at least two spans of 1/2 inch or greater, yellow or orange synthetic-fiber rope completely encompassing the safe work area and access ways, restricting entry to all restricted and/or hazardous areas. The top span shall be approximately 60 inches above the surface of the safe work area and the intermediate span approximately 36 inches high. Approved barricades shall be erected at substation ground level and at all levels in the buswork or structures where employees are required to work. They shall be positioned in such a manner that no employee can contact energized lines or equipment without violating the barricade. Additional barricades may may be necessary dependent upon existing field conditions, and all barricades shall be subject to approval of the Contracting Officer's representative.

b. Approved-type signs. Danger signs, as described in paragraph 9.2.3, of nonconductive material and at least 10 by 14 inches in size shall be suspended at midspan of each section of all barricades except in the buswork or structures. Such signs shall be placed directly above the beams where the beams enter the restricted area. The danger signs shall contain the following wording: **HIGH VOLTAGE-KEEP OUT.**

28.5 ADDITIONAL SAFETY REQUIREMENTS

28.5.1 ***Control panels.*** Only qualified and experienced switchboard electricians shall be permitted to work on energized control panels. Adequate precautions including the use of accident prevention tags shall be taken to prevent accidental operation of switches. Also, care shall be taken to prevent operation of relays or other protective devices due to jarring, vibration, contact, or improper wiring.

28.5.2 ***Mechanized equipment.*** Movement of vehicles, gin poles, cranes, and other hoisting or mechanized equipment used in substations shall be controlled by signalmen or flagmen.

28.5.3 ***Equipment grounding.*** Rubber-mounted hoisting equipment shall be equipped with ground chains. All hoisting equipment shall be bonded to the station groundmat when operated in a stationary position.

28.5.4 ***Material storage.*** No materials or equipment shall be stored under an energized bus or lines, or near energized equipment.

28.5.5 ***Handling materials.*** Extreme caution shall be exercised in the handling of bus or tower steel, or other materials of a length that could contact energized facilities. Such materials shall not be carried on the shoulder.

28.5.6 ***Substation fences.*** When a substation fence must be extended or removed for construction purposes, a temporary fence affording comparable protection shall be erected. Such temporary fencing, when constructed of metal, shall be bonded to the existing fence. All substation gates shall be kept closed and locked except when work is in progress and access can be controlled.

28.5.7 ***Operating equipment near high-voltage lines.*** Operation of equipment near energized high-voltage lines or facilities shall conform to the requirements and distance restrictions set forth in paragraph 12.9.4.

28.5.8 ***Completion of work.*** When the Contracting Officer's onsite representative considers all work in a particular facility to be completed, he will notify the contractor's representative, in writing, requesting him to remove all grounds and not to perform any further work in the area.

Section 29

MARINE AND DIVING OPERATIONS

29.1 MARINE OPERATIONS

29.1.1 ***Inspection and certification.*** All marine plant and equipment shall be inspected, certified, licensed, and numbered as required under the regulations of the U.S. Coast Guard or other jurisdictional entities before being placed in service.

29.1.2 ***Operator's license.*** The master, pilot, and crewmen of marine plant shall have in their possession a current license or certification as required by the U.S. Coast Guard or other jurisdictional entities. Operators of motor vessels 26 feet or longer, or vessels assigned to transport more than 10 persons shall possess a current U.S. Coast Guard Motor Board Operator's License.

29.1.3 ***Inspections.*** Prior to use, all marine plant and equipment shall be inspected and tested by a qualified person and determined to be in safe operating condition. Periodic inspections shall be made thereafter to ensure safe operating condition. Craft found to be in unsafe condition shall be removed from service until the unsafe condition has been corrected.

29.1.4 ***Capacity plates.*** All watercraft shall have plainly marked thereon the maximum number of persons that can safely be carried, and the number shall not be exceeded.

29.1.5 ***Lifevests.*** U.S. Coast Guard approved life preservers or lifevests shall be worn by the crew and passengers traveling on or working from all launches, motorboats, outboards, skiffs, dredges, and floating platforms, unless employees are protected by standard guardrails. In any case, life preservers for each crew member and passenger will be readily available aboard the watercraft.

29.1.6 ***Fire extinguishers.*** At least one U.S. Coast Guard approved dry chemical fire extinguisher, rated at least 5 B:C, shall be carried on all launches and motorboats including outboards. Launches and motorboats having gasoline or liquid petroleum gas powerplants located in a confined space shall be equipped with a built-in automatic CO^2 (carbon dioxide), or equally effective, automatic fire extinguishing system.

29.1.7 ***Gasoline-powered motorboats.*** Gasoline-powered motorboats or launches, except outboards, shall be equipped with a mechanical exhaust system for ventilating the engine space and bilges. The system shall be interlocked with the ignition to ensure venting prior to starting.

29.1.8 ***Fuel.*** Fuel valves shall be provided on all fuel feedlines and shall be closed during inoperative periods exceeding 8 hours.

29.1.9 ***Carburetors.*** Carburetors on gasoline engines shall be equipped with a backfire trap or flame arrestor.

29.1.10 ***Operation safety.*** All boats shall have sufficient space for cargo and passengers, and shall not be overloaded. Due consideration shall be given to weather and water conditions, and all operations shall be suspended in the event of storms rendering operations unsafe.

29.2 DIVING OPERATIONS

29.2.1 ***General requirement.*** Conventional hardhat and lightweight surface supplied and scuba diving operations shall be governed by the more stringent requirements of this subsection or 29 CFR, Part 1910, subpart T, "Commercial Diving Operations."

Regulations contained in the U.S. Navy Diving Manual shall be used to resolve issues not covered by the aforementioned regulations.

29.2.2 *Conventional diving*

a. Diver qualification. Divers, including those on standby, shall possess evidence of qualification in the form of a certificate of training from a recognized diving school or certified record of past diving experience. Divers shall be at least 18 years of age, be fully familiar with the equipment and diving system to be used, and possess evidence of a medical examination within the previous 12 months which certifies that the diver is physically fit for diving. In addition, no one shall be employed as a deep diver unless he has been gradually introduced or reintroduced to the maximum depth at which he is to dive. Diver's suffering from severe colds, sinus, or ear trouble, alcoholic intoxication or its after effects, drug addiction, fatigue, acute illness, or vertigo shall not be permitted to participate in diving operations.

b. Supervision. All diving operations including utilization of personnel and decompression shall be under the personal supervision of a competent diving master.

c. Minimum crew size. A minimum of two divers shall be available on any one diving operation. The standby diver shall be available, suited up, and ready to dive in an emergency, and shall not serve as a tender. The minimum crew shall consist of at least four men; the diving master, a diver, a standby diver, and a tender. For each diver added to the crew, one tender shall also be added.

d. Auxiliary air supply. An auxiliary air supply consisting of a standby compressor or air flasks shall be available during all dives. Compressors used in diving operations shall be independent of any other use.

e. Decompression. Decompression tables shall be prepared by recognized decompression specialists. Recompression times shall be posted inside and outside of recompression chambers.

f. Recompression chamber. A recompression chamber with trained operating personnel shall be required onsite in diving operations where stage decompression in excess of 30 minutes is planned. Further, a recompression chamber shall be required for all diving operations where an offsite chamber is not reasonably available for emergency use.

g. Communications. Divers and standby divers shall be equipped with phones permitting simultaneous two-way conversations between the diver, his tender, other divers, and other tenders and the diving master.

h. Surface decompression. Surface decompression shall not be carried out unless the following conditions are satisfied:

(1) A recompression chamber with a working pressure of at least 75 lb/in^2 is available onsite.

(2) Sufficient trained personnel for operating the chamber are available.

i. Stage decompression. A diver who has just completed stage decompression and an attendant shall remain on duty for an additional hour before being released from duty. The diver shall be able to contact a recompression chamber facility during the 4-hour period immediately after leaving the water.

29.2.3 *Scuba diving*

a. Requirement. Scuba diving shall not be permitted unless sanctioned by the contract specifications or authorized in writing by the Contracting Officer. All requests for such authorization shall contain the following information and shall be subject to the requirements of this subsection:

(1) Names and qualifications of divers to be used in the operation

(2) A complete description of the proposed diving operations including equipment to be used and safety precautions to be taken

b. Maximum depths. Scuba diving shall be limited to depths and to times that will not require decompression staging as set forth in the U.S. Navy Standard Decompression Tables. Scuba dives shall not exceed 100 feet in depth for any operation.

c. Compressed air. The use of scuba diving equipment shall be limited to the open-circuit type using compressed air only. Use of oxygen or mixed gases shall not be permitted.

d. Diving equipment. Scuba diving equipment shall be of a type that has been approved by a recognized approving agency, and the equipment shall be used and maintained in accordance with the manufacturer's recommendations.

e. Diver qualifications. Scuba divers shall possess the qualifications and present evidence of medical examinations as set forth in subparagraph 29.2.2a.

f. Supervision. All diving operations shall be under the personal supervision of a competent diving master.

g. Buddy system. Scuba dives less that 33 feet in depth in lakes or reservoirs where there is little current may be made singly at the option of the diving master. In dives over 33 feet in depth, the buddy pair system shall be used or the diver tethered. Buddy pair divers must maintain visual contact or use a buddy line securely fastened to both divers. When working in fast currents, murky water, or in confined spaces, a tether line shall be attached to the diver and it shall be continuously tended from the surface.

h. Surface tenders. A surface tender shall be provided for each diver or buddy pair. The tender shall be a qualified and fully equipped scuba diver, located on the surface in close proximity to the divers.

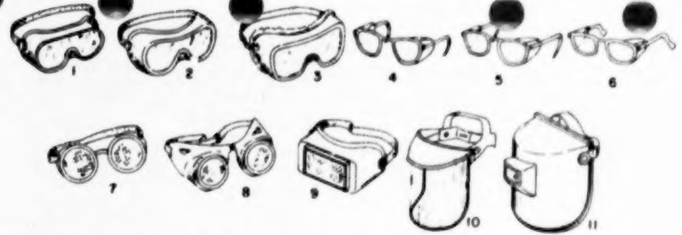
i. Emergency equipment. Scuba divers shall wear buoyancy compensators and have a watch, compass, depth indicator, and a knife on all dives.

Section 30

DEMOLITION

30.1. ***Requirement.*** All demolition operations shall be performed in compliance with CFR Title 29, Part 1926, Safety and Health Regulations for Construction, subpart T, "Demolition," published by the U.S. Department of Labor.

Appendix A—EYE AND FACE PROTECTION SELECTION GUIDE



1. GOGGLES, Flexible Fitting, Regular Ventilation
2. GOGGLES, Flexible Fitting, Hooded Ventilation
3. GOGGLES, Cushioned Fitting, Rigid Body

*4. SPECTACLES, Metal Frame, with Sideshields

*5. SPECTACLES, Plastic Frame, with Sideshields

*6. SPECTACLES, Metal - Plastic Frame, with Sideshields

**7. WELDING GOGGLES, Eyecup Type, Tinted Lenses
CHIPPING GOGGLES, Eyecup Type, Clear Safety Lenses (Not Illustrated)

**8. WELDING GOGGLES, Coverspec Type, Tinted Lenses
CHIPPING GOGGLES, Coverspec Type, Clear Safety Lenses (Not Illustrated)

**9. WELDING GOGGLES, Coverspec Type, Tinted Plate Lens

10. FACE SHIELD (Available with Plastic or Mesh Window)

**11. WELDING HELMETS

*Nonsideshield spectacles are available for limited hazard use requiring only frontal protection
**Refer to appendix B, Required Shades for Filter Lenses and Glasses.

Figure 1.—Eye and face protection apparatus

Appendix A (CONTINUED)

Table 1.—*Eye and face protection application selection guide*

APPLICATIONS		
OPERATION	HAZARDS	RECOMMENDED PROTECTORS (Bold Type Numbers Signify Preferred Protection)
ACETYLENE - BURNING ACETYLENE - CUTTING ACETYLENE - WELDING	SPARKS, HARMFUL RAYS, MOLTEN METAL, FLYING PARTICLES	7, 8, 9
CHEMICAL HANDLING	SPLASH, ACID BURNS, FUMES	2, 10 (For severe exposure add 10 over 2)
CHIPPING	FLYING PARTICLES	1, 3, 4, 5, 6, 7A, 8A
ELECTRIC (ARC) WELDING	SPARKS, INTENSE RAYS, MOLTEN METAL	9, 11 (11 in combination with 4, 5, 6, in tinted lenses, advisable)
FURNACE OPERATIONS	GLARE, HEAT, MOLTEN METAL	7, 8, 9, (For severe exposure add 10)
GRINDING - LIGHT	FLYING PARTICLES	1, 3, 4, 5, 6, 10
GRINDING - HEAVY	FLYING PARTICLES	1, 3, 7A, 8A, (For severe exposure add 10)
LABORATORY	CHEMICAL SPLASH, GLASS BREAKAGE	2 (10 When in combination with 4, 5, 6)
MACHINING	FLYING PARTICLES	1, 3, 4, 5, 6, 10
MOLTEN METALS	HEAT, GLARE, SPARKS, SPLASH	7, 8 (10 in combination with 4, 5, 6, in tinted lenses)
SPOT WELDING	FLYING PARTICLES, SPARKS	1, 3, 4, 5, 6, 10

Appendix B - REQUIRED SHADES FOR FILTER LENSES AND GLASSES

Table 1.—*Shade selection guide for lenses and glasses*

Operation	Shade No.
Atomic hydrogen welding	10-14
Carbon arc welding	14
Shielded metal-arc:	
1/16-, 3/32-, 1/8-, 5/32-inch-diameter electrodes	10
3/16-, 7/32-, 1/4-inch-diameter electrodes	12
5/16-, 3/8-inch-diameter electrodes	14
Inert-gas metal-arc welding (nonferrous):	
1/16-, 3/32-, 1/8-, 5/32-inch-diameter electrodes	11
Inert-gas metal-arc welding (ferrous):	
1/16-, 3/32-, 1/8-, 5/32-inch-diameter electrodes	12
Gas welding:	
Heavy - 1/2 inch and over	6 or 8
Medium - 1/8 to 1/2 inch	5 or 6
Light - up to 1/8 inch	4 or 5
Cutting:	
Heavy - 6 inches or over	5 or 6
Medium - 1 to 6 inches	4 or 5
Light - up to 1 inch	3 or 4
Torch brazing	3 or 4
Soldering	2

NOTE: In gas welding or oxygen cutting where the torch produces a high yellow light, a filter or lens that absorbs the yellow or sodium light should be used.

Appendix C - RESPIRATOR SELECTION

(RESERVED)

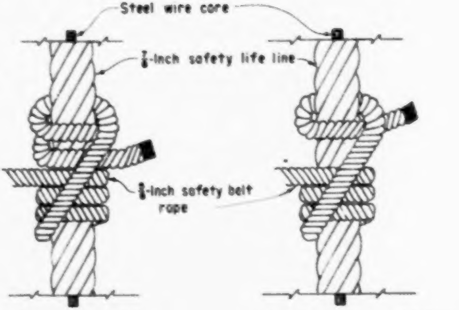
Appendix C (CONTINUED)

(RESERVED)

Appendix C (CONTINUED)

(RESERVED)

Appendix D - SCALER'S HITCH

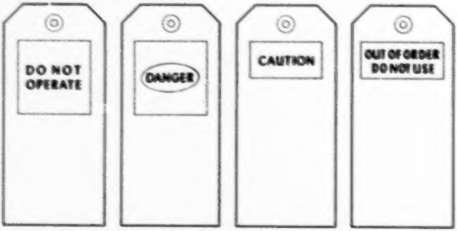

Steel wire core
$\frac{7}{8}$-inch safety life line
$\frac{3}{8}$-inch safety belt rope

2 Loops above and 3 loops below safety belt rope.

Single loop above and 3 loops below safety belt rope.

Figure 1.—Scaler's hitch

Appendix E - ACCIDENT PREVENTION TAGS


DO NOT OPERATE
DANGER
CAUTION
OUT OF ORDER DO NOT USE

White tag - White letters on red square.

White tag - White letters on red oval with a black square.

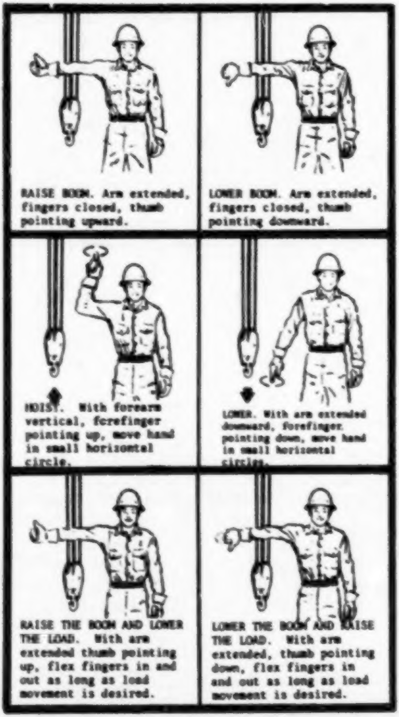
Yellow tag - Yellow letters on a black background.

White tag - White letters on black background.

Basic Stock (Background)	Safety Colors (Ink)	Copy Specification (Letters)
White	Red	Do Not Operate
White	Black and Red	Danger
Yellow	Black	Caution
White	Black	Out of Order Do Not Use

Figure 1.—Warning tags

Appendix F - HAND SIGNALS FOR CRANES AND HOISTING EQUIPMENT



RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.

LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.

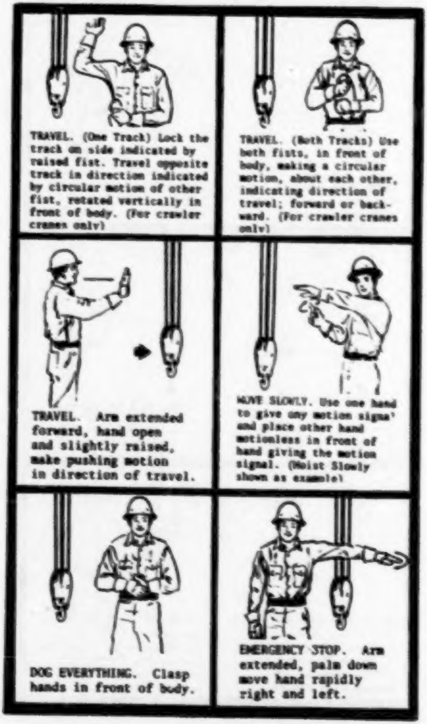
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.

RAISE THE BOOM AND LOWER THE LOAD. With arm extended thumb pointing up, flex fingers in and out as long as load movement is desired.

LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

Figure 1.—Hand signals for cranes and hoisting equipment (Sheet 1 of 4)



TRAVEL. (One Track) Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For crawler cranes only)

TRAVEL. (Both Tracks) Use both fists, in front of body, making a circular motion, about each other, indicating direction of travel; forward or backward. (For crawler cranes only)

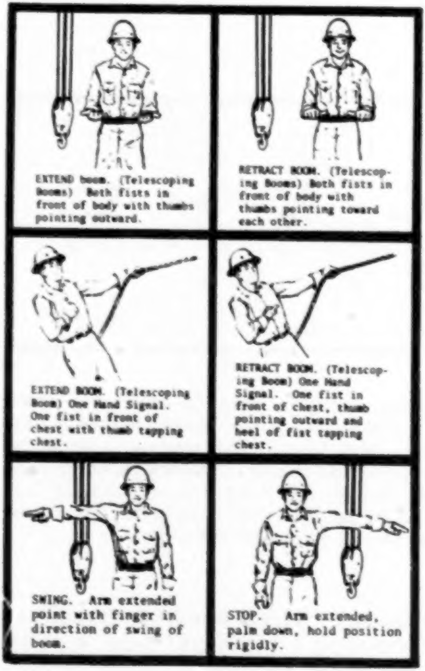
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.

MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly shown as example)

DOG EVERYTHING. Clasp hands in front of body.

EMERGENCY STOP. Arm extended, palm down move hand rapidly right and left.

Figure 1.—Hand signals for cranes and hoisting equipment (Sheet 2 of 4)



EXTEND boom. (Telescoping Booms) Both fists in front of body with thumbs pointing outward.

RETRACT BOOM. (Telescoping Booms) Both fists in front of body with thumbs pointing toward each other.

EXTEND BOOM. (Telescoping Boom) One Hand Signal. One fist in front of chest with thumb tapping chest.

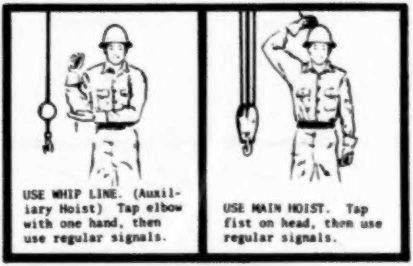
RETRACT BOOM. (Telescoping Boom) One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

SWING. Arm extended point with finger in direction of swing of boom.

STOP. Arm extended, palm down, hold position rigidly.

Figure 1.—Hand signals for cranes and hoisting equipment (Sheet 3 of 4)

Appendix F (CONTINUED)



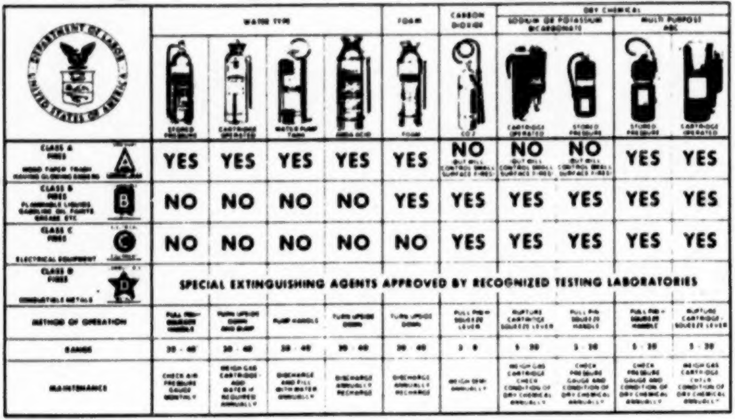
USE WHIP LINE. (Auxiliary Hoist) Tap elbow with one hand, then use regular signals.

USE MAIN HOIST. Tap fist on head, then use regular signals.

Recommended by USA Standards Committee B30, "Safety Code for Cranes, Derricks, Hoists, Jacks, and Slings," and reproduced from the proposed USA standard "Safety Code for Crawler, Locomotive, and Truck Cranes," USAS B30.5, with the permission of the publisher, The American Society of Mechanical Engineers.

Figure 1.—Hand signals for cranes and hoisting equipment (Sheet 4 of 4)

Appendix G - FIRE EXTINGUISHER DATA



	WATER TYPE				FOAM	CARBON DIOXIDE	DRY CHEMICAL			
							SODIUM OR POTASSIUM BICARBONATE		MULTI PURPOSE ABC	
	STORED PRESSURE	CARTRIDGE OPERATED	WATER PUMP TANK	SODA ACID	FOAM	CO2	CARTRIDGE OPERATED	STORED PRESSURE	STORED PRESSURE	CARTRIDGE OPERATED
CLASS A FIRES WOOD PAPER TRASH HAVING GLOWING EMBERS	YES	YES	YES	YES	YES	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	YES	YES
CLASS B FIRES FLAMMABLE LIQUIDS GASOLINE OIL PAINTS GREASE ETC	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES
CLASS C FIRES ELECTRICAL EQUIPMENT	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
CLASS D FIRES COMBUSTIBLE METALS	SPECIAL EXTINGUISHING AGENTS APPROVED BY RECOGNIZED TESTING LABORATORIES									
METHOD OF OPERATION	PULL PIN SQUEEZE HANDLE	TURN UPSIDE DOWN AND BUMP	PUMP HANDLE	TURN UPSIDE DOWN	TURN UPSIDE DOWN	PULL PIN SQUEEZE LEVER	RUPTURE CARTRIDGE SQUEEZE LEVER	PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE	RUPTURE CARTRIDGE SQUEEZE LEVER
RANGE	30 - 40'	30 - 40	30 - 40	30 - 40	30 - 40	3 - 8	5 - 20	5 - 20	5 - 20	5 - 20
MAINTENANCE	CHECK AIR PRESSURE GAUGE MONTHLY	WEIGH GAS CARTRIDGE - ADD WATER IF REQUIRED ANNUALLY	DISCHARGE AND FILL WITH WATER ANNUALLY	DISCHARGE ANNUALLY RECHARGE	DISCHARGE ANNUALLY RECHARGE	WEIGH SEMI ANNUALLY	WEIGH GAS CARTRIDGE CHECK CONDITION OF DRY CHEMICAL ANNUALLY	CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY	CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY	WEIGH GAS CARTRIDGE CHECK CONDITION OF DRY CHEMICAL ANNUALLY

Figure 1.—Fire extinguisher data

Appendix H - INSPECTION SCHEDULE FOR FIRE PROTECTION EQUIPMENT

Table 1.—*Equipment inspection schedule*

Item	Inspection interval	Procedure
1. All portable and wheeled-type extinguishers	Monthly	Check all extinguishers for proper locations. Visually inspect for damage, leakage, and to determine if extinguisher is fully loaded and operable. If necessary, recharge and correct deficiencies.
	Annually	Refer to appendix G, for annual maintenance of specific types of extinguishers; also to NFPA No. 10A, "Maintenance and Use of Portable Fire Extinguishers."
2. Main generator CO^2 system	Monthly	Check electrical control circuits and indicating lights.
	Semi-annually	Weigh all cylinders and refill if necessary. Test and check system in accordance with the manufacturer's recommendations.
3. Sprinkler systems	Bimonthly	Check water supply controls. Test fire pumps and flush out lines.

Table 1.—*Equipment inspection schedule (Continued)*

4. Fire doors and shutters	Monthly	Inspect and manually operate.
	Semi-annually	Test operation of automatic firedoors and dampers. Lubricate rollers and cleanout channels.
5. Fire pails, drums, and tanks	Monthly	Check for condition and location. Refill and add antifreeze solution as required.
6. Fire hose stations	Monthly	Inspect nozzles, hoses, and connections. Discard and replace defective hose.
	Annually	Test flow and hydrant pressure. Thoroughly inspect and test hose.
7. Fire alarm systems	Monthly	Service fire signal and controls. Test system for proper operation.
8. Transformer fog system	Daily	Check pilot lights indicating that system is operable.
	Semi-annually	Thoroughly test and operate the system while the transformer bank is out of service.

Appendix I—COMMON FLAMMABLE AND COMBUSTIBLE LIQUIDS

Table I.—*Flammable liquids characteristics*

	Flash point	Class	Flammable (explosive) limits (percent by volume in air)	Characteristic
Ether (starting fluids)	-49 °F (-45 °C)	IA	1.9 to 36.0	Dangerous when heated or exposed to flame or sparks; tend to form explosive peroxides upon standing; shock sensitive; can react vigorously with oxidizing materials.
Gasoline	-45 °F (-45 °C)	IB	1.4 to 7.6	Dangerous when exposed to heat or flame; can react violently with oxidizing materials.
Acetone	0 °F (-18 °C)	IB	2.6 to 12.8	Dangerous when exposed to heat or flame; reacts vigorously with oxidizing materials.

Table 1.—*Flammable liquids characteristics (Continued)*

Methyl-thyl ketone (MEK - catalyst/hardener of fiber)	21 °F (-6 °C)	1B		Dangerous when exposed to heat or flame; can react with oxidizing materials.
Lacquer thinner	< 34 °F (<1 °C)	1B		Dangerous when exposed to heat or flame; emits toxic fumes when heated; reacts vigorously with oxidizing materials.
Toluene (Buckeye solvent)	40 °F (4 °C)	1B		Dangerous when exposed to heat or flame; emits toxic fumes when heated; reacts vigorously with oxidizing materials.
Isopropyl alcohol (glass cleaner)	53 °F (12 °C)	1B	2.0 to 12.0	Dangerous when exposed to heat or flame; can react vigorously with oxidizing materials.
Methyl-isobutyl ketone (MIBK)	73 °F (23 °C)	1B	1.4 to 7.5	Dangerous when exposed to heat or flame; can react vigorously with reducing materials.

Table 1.—*Flammable liquids characteristics (Continued)*

Naptha (Stoddard solvent)	**100 to 110 °F (38 to 43 °C)**	**II**	**0.8 to 5.0**	**Moderate fire hazard when exposed to heat or flame; emits acrid fumes when decomposed and may explode; can react with oxidizing materials.**
Diesel oil (fuel oil No. 2)	**125 °F (52 °C) or minimum legal**	**II**	**1.1 to 6.0**	**Moderate fire hazard when exposed to heat or flame; can react with oxidizing materials.**
Mineral Spirits (paint thinner)	**104 °F (40 °C)**	**II**	**0.8 at 212 °F (100 °C)**	**Moderate fire hazard when exposed to heat or flame; can react with oxidizing materials.**
Transformer oil	**145 °F (63 °C) minimum**			**Slight to moderate fire hazard when exposed to heat or flame; can react with oxidizing materials.**
Lube oil	**300 to 450 °F (149 to 232 °C)**	**III**		**Slight to moderate fire hazard when exposed to heat or flame; can react with oxidizing materials. Dangerous when heated to decomposition.**

Table 1.—*Flammable liquids characteristics (Continued)*

Asphalt tar (petroleum pitch)	400 °F (294 °C)	III		Slight to moderate fire hazard when exposed to heat or flame; can react with oxidizing materials. Dangerous when heated to decomposition.
Linseed oil	403 °F (206 °C)	III		Slight to moderate fire hazard when exposed to heat or flame; can react with oxidizing materials. Dangerous when heated to decomposition.
1,1,1-trichloroethane (methyl chloroform)	None	Nonflammable	None	Dangerous; when heated to decomposition, it emits highly toxic chloride fumes.
Trichloroethylene	None	Nonflammable	Not significant	Dangerous; when heated to decomposition, it emits highly toxic chloride fumes.

Appendix J-SINGLE- AND INDEPENDENT-POLE SCAFFOLDS

Table 1.—*Minimum nominal size and maximum spacing of members of single pole scaffolds—light duty*

	Maximum height of scaffold	
	20 ft.	60 ft.
Uniformly distributed load	Not to exceed 25 p.s.f.	
Poles or uprights	2 x 4 in.	4 x 4 in.
Pole spacing (longitudinal)	6 ft. 0 in.	10.ft. 0 in.
Maximum width of scaffold	5 ft. 0 in.	5 ft. 0 in.
Bearers or putlogs to 3 ft. 0 in. width	2 x 4 in.	2 x 4 in.
Bearers or putlogs to 5 ft. 0 in. width	2 x 6 in. or 3 x 4 in.	2 x 6 in. or 3 x 4 in. (rough).
Ledgers	1 x 4 in.	1¼ x 9 in.
Planking	1¼ x 9 in. (rough)	2 x 10 in.
Vertical spacing of horizontal members	7 ft. 0 in.	9 ft. 0 in.
Bracing, horizontal and diagonal	1 x 4 in.	1 x 4 in.
Tie-ins	1 x 4 in.	1 x 4 in.
Toeboards	4 in. high (minimum)	4 in. high (minimum).
Guardrail	2 x 4 in.	2 x 4 in.

Appendix J (CONTINUED)

Table 2.—*Minimum nominal size and maximum spacing of members of single pole scaffolds—medium duty*

Uniformly distributed load	Not to exceed 50 p.s.f.
Maximum height of scaffold	60 ft.
Poles or uprights	4 x 4 in.
Pole spacing (longitudinal)	8 ft. 0 in.
Maximum width of scaffold	5 ft. 0 in.
Bearers or putlogs	2 x 10 in. or 3 x 4 in.
Spacing or bearers of putlogs	8 ft. 0 in.
Ledgers	2 x 10 in.
Vertical spacing of horizontal members	7 ft. 0 in.
Bracing, horizontal	1 x 6 in. or 1¼ x 4 in.
Bracing, diagonal	1 x 4 in.
Tie-ins	1 x 4 in.
Planking	2 x 10 in.
Toeboards	4 in. high (minimum).
Guardrail	2 x 4 in.

Appendix J (CONTINUED)

Table 3—*Minimum nominal size and maximum spacing of members of single pole scaffolds—heavy duty*

Uniformly distributed load	Not to exceed 75 p.s.f.
Maximum height of scaffold	60 ft.
Poles or uprights	4 x 6 in.
Pole spacing (longitudinal).	6 ft. 0 in.
Maximum width of scaffold	5 ft. 0 in.
Bearers or putlogs	2 x 10 in. or 3 x 5 in.
Ledgers.	2 x 10 in.
Vertical spacing of horizontal members	6 ft. 6 in.
Bracing, horizontal and diagonal	2 x 4 in.
Tie-ins	1 x 4 in.
Planking	2 x 10 in.
Toeboards	4 in. high (minimum).
Guardrail	2 x 4 in.
Spacing of bearers or putlog	6 ft. 0 in.

Table 4—*Minimum nominal size and maximum spacing of members of independent pole scaffolds—light duty*

	Maximum height of scaffold	
	20 ft.	60 ft.
Uniformly distributed load	Not to exceed 25 p.s.f.	
Poles or uprights	2 x 4 in.	4 x 4 in.
Pole spacing (longitudinal)	6 ft. 0 in.	10 ft. 0 in.
Pole spacing (transverse).	6 ft. 0 in.	10 ft. 0 in.
Ledgers	1¼ x 4 in.	1¼ x 9 in.
Bearers to 3 ft. 0 in. span	2 x 4	2 x 4
Bearers to 10 ft. 0 in. span	2 x 6 or 3 x 4 in.	2 x 10 (rough) or 3 x 8 in.
Planking	1¼ x 9 in.	2 x 10 in.
Vertical spacing of horizontal members	7 ft. 0 in.	7 ft. 0 in.
Bracing, horizontal and diagonal	1 x 4 in.	1 x 4 in.
Tie-ins	1 x 4 in.	1 x 4 in.
Toeboards	4 in. high	4 in. high (minimum)
Guardrail	2 x 4 in.	2 x 4 in.

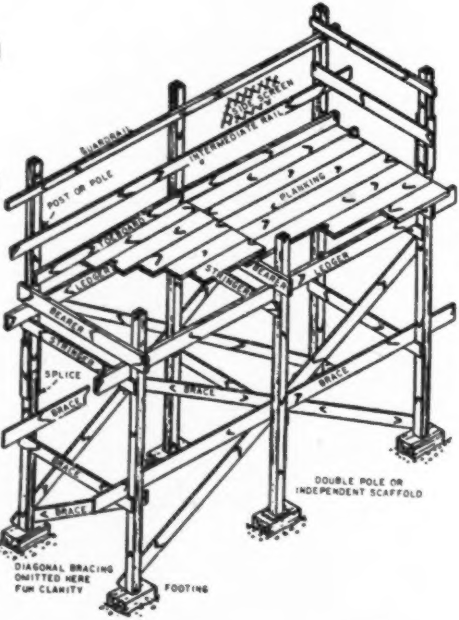
Table 5—*Minimum nominal size and maximum spacing of members of independent pole scaffolds—medium duty*

Uniformly distributed load	Not to exceed 50 p.s.f.
Maximum height of scaffold	60 ft.
Poles or uprights	4 x 4 in.
Pole spacing (longitudinal)	8 ft. 0 in.
Pole spacing (transverse)	8 ft. 0 in.
Ledgers	2 x 10 in.
Vertical spacing of horizontal members	6 ft. 0 in.
Spacing of bearers	8 ft. 0 in.
Bearers	2 x 10 in.
Bracing, Horizontal	1 x 6 in. or 1¼ x 4 in.
Bracing, diagonal	1 x 4 in.
Tie-ins	1 x 4 in.
Planking	2 x 10 in.
Toeboards	4 in. high (minimum)
Guardrail	2 x 4 in.

Table 6—*Minimum nominal size and maximum spacing of members of independent pole scaffolds—heavy duty*

Uniformly distributed load	Not to exceed 75 p.s.f.
Maximum height of scaffold	60 ft.
Poles or uprights	4 x 4 in.
Pole spacing (longitudinal)	6 ft. 0 in.
Pole spacing (transverse)	8 ft. 0 in.
Ledgers	2 x 10 in.
Vertical spacing of horizontal members	6 ft. 0 in.
Bearers	2 x 10 in. (rough)
Bracing, horizontal and diagonal	2 x 4 in.
Tie-ins	1 x 4 in.
Planking	2 x 10 in.
Toeboards	4 in. high (minimum)
Guardrail	2 x 4 in.

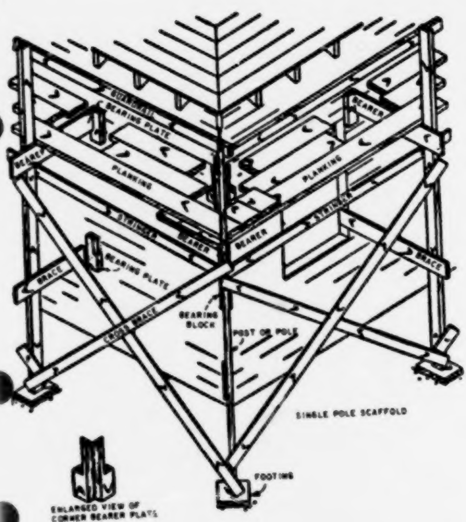
Appendix K - INDEPENDENT WOOD-POLE SCAFFOLD DESIGN


GUARDRAIL
SIDE SCREEN
INTERMEDIATE RAIL
POST OR POLE
PLANKING
TOEBOARD
LEDGER
STRINGER
BEARER
LEDGER
BEARER
STRINGER
SPLICE
BRACE
BRACE
BRACE
BRACE
BRACE
DOUBLE POLE OR INDEPENDENT SCAFFOLD
DIAGONAL BRACING OMITTED HERE FOR CLARITY
FOOTING

Note: Refer to Appendix J for size and spacing of wood members.

Figure 1.—Independent wood-pole scaffold

Appendix L - SINGLE-POLE WOOD-POLE SCAFFOLD DESIGN


GUARDRAIL
BEARING PLATE
BEARER
PLANKING
STRINGER
BEARER
BEARER
BEARING PLATE
BRACE
CROSS BRACE
BEARING BLOCK
POST OR POLE
BEARER
PLANKING
STRINGER
BEARER
BRACE
SINGLE POLE SCAFFOLD
FOOTING
ENLARGED VIEW OF CORNER BEARER PLATE

Note: Refe: to Appendix J for size and spacing of wood members.

Figure 1.—Single-pole wood-pole scaffold design

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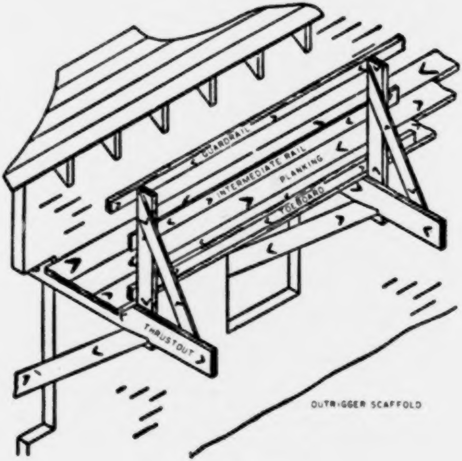
—FICHE—

Appendix M - OUTRIGGER SCAFFOLD DESIGN


GUARDRAIL
INTERMEDIATE RAIL
PLANKING
TOEBOARD
THRUSTOUT
OUTRIGGER SCAFFOLD

Note: Refer to subsection 13.7 for size and spacing of members.

Figure 1.—Outrigger scaffold design

Appendix N - SPECIFICATIONS FOR LADDER-TYPE PLATFORMS

Table 1.—*Ladder-type platform specification*

	LENGTH OF PLATFORM (FEET)				
	12	14 and 16	18 and 20	22 and 24	28 and 30
Side Stringers, minimum cross-section (finished sizes):					
At ends (inches)	1¾ x 2¾	1¾ x 2¾	1¾ x 3	1¾ x 3	1¾ x 3½
at midle (inches)	1¾ x 3¾	1¾ x 3¾	1¾ x 4	1¾ x 4¼	1¾ x 5
Reinforcing strip (minimum)	A 1/8 x 7/8-inch steel reinforcing strip or its equivalent shall be attached to the side or underside, full length.				
Rungs	Rungs shall be 1-1/8-inches minimum diameter with at least 7/8 inch diameter tenons and the maximum spacing shall be 12 inches center to center.				
Tie rods:					
Number (minimum)	3	4	4	5	6
Diameter (minimum)	¼ in.	¼ in.	¼ in.	¼ in.	¼ in.
Flooring, minimum finished size (inches)	½ x 2¾	½ x 2¾	½ x 2¾	½ x 2¾	½ x 2¾

Appendix O - TUBE AND COUPLER SCAFFOLDS

Table 1.—*Tube and coupler scaffolds—light duty*

Uniformly distributed load	Not to exceed 25 p.s.f.
Post spacing (longitudinal)............	10 ft. 0 in.
Post spacing (transverse)...............	6 ft. 0 in.

Working levels	Additional planked levels	Maximum height
1	8	125 ft.
2	4	125 ft.
3	0	91 ft. 0 in.

Table 2.—*Tube and coupler scaffolds-medium duty*

Uniformly distributed load	Not to exceed 50 p.s.f.
Post spacing (longitudinal)............	8 ft. 0 in.
Post spacing (transverse)	6 ft. 0 in.

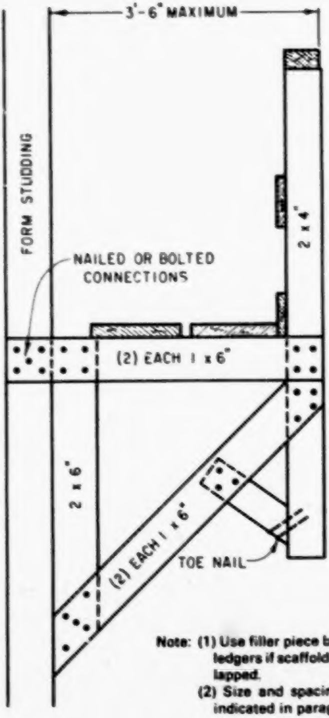
Working levels	Additional planked levels	Maximum height
1	6	125 ft.
2	0	78 ft. 0 in.

Table 3.—*Tube and coupler scaffolds—heavy duty*

Uniformly distributed load	Not to exceed 75 p.s.f.
Post spacing (longitudinal)	6 ft. 6 in.
Post spacing (traverse)	6 ft. 0 in.

Working levels	Additional planked levels	Maximum height
1	6	125 ft.

Appendix P - FIGURE-FOUR FORM SCAFFOLD


3'-6" MAXIMUM
FORM STUDDING
NAILED OR BOLTED CONNECTIONS
2 x 4"
(2) EACH 1 x 6"
2 x 6"
(2) EACH 1 x 6"
TOE NAIL

Note: (1) Use filler piece between 1 by 6-inch ledgers if scaffold planks are not overlapped.
(2) Size and spacing of members are indicated in paragraph 13.21.4.

Figure 1.—Figure-four scaffold design

Appendix Q - METAL BRACKET FORM SCAFFOLD

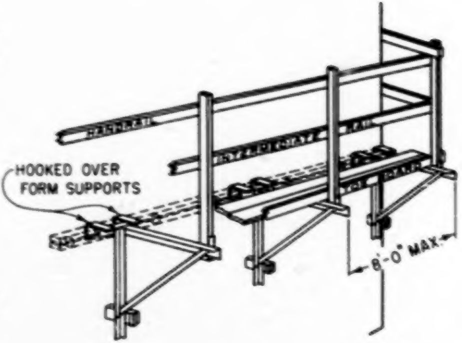
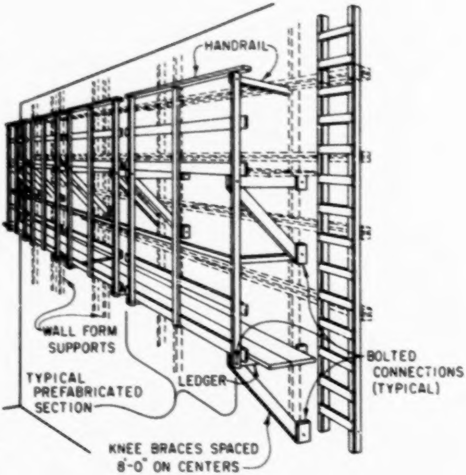

HOOKED OVER
FORM SUPPORTS
8'-0" MAX.

Figure 1.—Metal bracket scaffold design

Appendix R - WOODEN BRACKET FORM SCAFFOLD

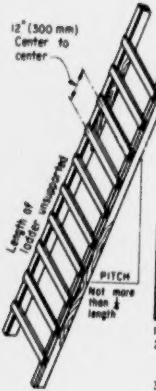

HANDRAIL
WALL FORM SUPPORTS
TYPICAL PREFABRICATED SECTION
LEDGER
BOLTED CONNECTIONS (TYPICAL)
KNEE BRACES SPACED 8'-0" ON CENTERS

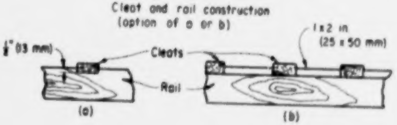
Note: (1) Scaffold can be prefabricated for attachment to wall forms at various positions, or it can be made as a permanent part of a movable form panel.

(2) Size and spacing of members is indicated in paragraph 13.21.6.

Figure 1.—Wooden bracket scaffold design

Appendix S - SINGLE-CLEAT LADDER DESIGN


12" (300 mm)
Center to center
Length of ladder unsupported
PITCH
Not more than ¼ length


Cleat and rail construction
(option of a or b)
$\frac{1}{8}$" (03 mm)
Cleats
1 x 2 in
(25 x 50 mm)
Rail
(a)
(b)

LADDER CONSTRUCTION[3]

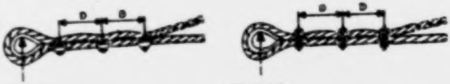
LENGTH[2]	MINIMUM INSIDE WIDTH		MAXIMUM INSIDE WIDTH		RAIL CROSS SECTION[1]		CLEAT CROSS SECTION	
	in	mm	in	mm	in	mm	in	mm
Through 16 ft (4.5 m)	20	510	24	610	2 x 4	50 x 100	1 x 3	25 x 75
From 16 ft (4.5 m) through 24 ft (7.0 m)	20	510	24	610	2 x 4	50 x 100	1 x 4	25 x 100

1. Customary trade sizes and SI "soft" Metric converted trade sizes.
2. Fixed ladders shall follow dimensions given for single cleat ladders and may exceed 24 ft (7m) in height, provided they are securely fixed or braced at intervals of not more than 15 ft (4.5m).
3. Safety code ASA A 10.2 from Corps of Engineers EM 385-1-1

Figure 1.—Single-cleat ladder design

Appendix T - WIRE ROPE CLIPS

How to Attach Wire Rope Clips



U-Bolt Clip

Fist Grip Clip

Thimble

U-Bolt of All clips on dead end of rope.

Never stagger clips.

Never put U-Bolt of clip on live end of rope.

Thimble

Note: D = six times diameter of wire rope

NUMBER OF CLIPS AND THE PROPER TORQUE NECESSARY TO ASSEMBLE WIRE ROPE EYE LOOP CONNECTIONS WITH A PROBABLE EFFICIENCY NOT MORE THAN 80 PERCENT.

Rope diameter (in.)	Nominal size of clips	Number of clips	Torque to be applied to nuts of clips (ft-lbs)
5/16	3/8	3	25
3/8	3/8	3	25
7/16	1/2	4	40
1/2	1/2	4	40
5/8	5/8	4	65
3/4	3/4	5	100
7/8	1	5	165
1	1	6	165
1-1/4	1-1/4	7	250
1-3/8	1-1/2	7	375
1-1/2	1-1/2	8	375
1-3/4	1-3/4	8	560

The spacing of clips should be six times the diameter of the wire rope. Thimbles shall be used if wire rope is to be spliced.

Figure 1.—Attaching wire rope clips

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ppendix U - REMOVAL OF SLINGS FROM SERVICE

Chain Slings

1. If wear at any point of any chain link or the depth of gouge or nded out portion exceeds the values in Table I, below, the embly shall be removed form service.

able 1 — *Maximum allowable wear at any point of link*

CHAIN SIZES INCHES	MAXIMUM ALLOWABLE WEAR, INCH	CHAIN SIZE, INCHES	MAXIMUM ALLOWABLE WEAR, INCH
1/4	3/64	1	3/16
3/8	5/64	1-1/8	7/32
1/2	7/64	1-1/4	1/4
5/8	9/64	1-3/8	9/32
3/4	5/32	1-1/2	5/16
7/8	11/64	1-3/4	11/32

2 Sharp transverse nicks shall be rounded by grinding.

3. Assemblies with deformed master or coupling links or cracked oks or attachments shall be removed from service.

Wire Rope Slings.

One or more of the following conditions shall be sufficient son for replacing wire rope slings:

1. Six randomly distributed broken wires in one rope lay, or ee broken wires in one strand in one rope lay.

2. Wear or scraping of one-third the original diameter of outside lividual wires.

3. Kinking, crushing, bird caging or any other damage resulting distortion of the rope structure.

4. Evidence of heat damage.

5. End attachments that are cracked, deformed, or worn.

6. Corrosion of the rope or end attachments.

C. Natural and Synthetic Fiber Rope Slings.

One or more of the following conditions shall be sufficient reason for replacing natural or synthetic fiber rope slings:

1. Slings shortened with knots, bolts, or other unapproved methods.

2. Damaged slings.

3. Rope less than ½-inch diameter.

4. Slings subjected to a sustained load equal to the rated capacity for more than three days.

5. Slings made from old rope.

6. Slings subjected to chemically active environments unless permitted by the rope manufacturer.

D. Synthetic Webbing.

One or more of the following visable defects shall be sufficient reason for replacing synthetic webbing:

1. Acid or caustic burns.

2. Melting or charring of any part of the surface.

3. Snags, punctures, tears or cuts.

4. Broken or worn stitches.

5. Wear or elongation exceeding the amount recommended by the manufacturer.

6. Distortion of fittings.

E. Metal Mesh.

Slings shall be removed from service if any of the following defects are present:

1. A broken weld or brazed joint along the sling edge.

2. A broken wire in any part of the mesh.

3. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.

4. Lack of flexibility due to distortion of the fabric.

5. Distortion of the female handle so the depth of the slot is increased by more than 10 percent.

F. Hooks.

Assemblies shall be removed from service if hooks have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

Appendix V - RECORD OF INSPECTION AND TEST FOR CRANES AND HOISTING EQUIPMENT

1. General. All mobile cranes shall be inspected and tested by the owner and/or the contractor (a) prior to initial onsite operation, (b) at least once each 12-month period, and (c) whenever the crane is modified, altered, or undergoes extensive repair, including rerigging. Such inspections and tests will be conducted in the presence of a Bureau representative and a "Record of Inspection and Test" recorded form number 7-1801 and submitted to the Contracting Officer's authorized representative or other appropriate Bureau representative. Initial onsite crane tests and inspections will be conducted at the worksite after the crane has been assembled and rigged for operation. Prior manufacturer or owner's preshipment inspection and testing program shall not be substituted for such requirements.

2. Inspection. Cranes will not be tested or operated until appropriate inspection records have been provided for review, all accessories and components required by Reclamation regulations and/or referenced standards are installed and in satisfactory working order (See reverse side for required components and accessories.)

2.1 Crane Components Requiring Inspection. Deficiencies requiring upgrading to original safety factor or condition before operation of crane is permitted.

2.1.1 Crane Structure, Main Boom, and Jib Boom.

(a) Deformed, cracked, or corroded members.

(b) Loose bolts or rivets.

(c) Critically cracked or worn sheaves, pins, shafts, gears, rollers, and locking devices.

2.1.2 Load Hooks and Hook Blocks.

(a) Hooks and blocks not permanently labeled with rated capacity.

(b) Hooks and hoist blocks not counterweighted to overhaul line from highest hook position.

(c) Hooks having cracks or having more than 15 percent excess normal throat opening or more than 10° twist from the plane of unbent hook.

2.1.3 Ropes.

(a) Ropes are not of proper size, grade, or construction for the particular performance or function

(b) In running ropes, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one rope lay. (A rope lay is the length along the rope in which one strand makes a complete revolution around the rope.)

(c) In pendants or standing ropes, evidence of more than one broken wire in one lay.

(d) Abrasion, scrubbing, or peening causing loss of more than one-third of the original diameter of the outside wires.

(e) Evidence of severe corrosion.

(f) Severe kinking, crushing, or other damage resulting in distortion of the rope structure.

(g) Evidence of any heat damage from a torch or arc caused by contact with electrical wires.

(h) Reduction from nominal rope diameter of more than 3/64 inch for diameters up to and including 3/4 inch; 1/16 inch for diameters 7/8 to 1-1/8 inches 3/32 inch for diameters 1-1/4 to 1-1/2 inches. Marked reduction in diameter indicates deterioration of the core, resulting in lack of proper support for the load carrying strands. Excessive rope stretch or elongation may also be an indication of internal deterioration.

(i) Evidence of "bird caging" or other distortion resulting in some members of the rope structure carrying more load than others

(j) Noticeable rusting or development of broken wires in the vicinity of attachments.

2.1.4 Hydraulic Hose, Fittings, and Tubing. All hydraulic hoses, and particularly those which flex in normal operation of crane functions, should be visually inspected once every working day. A thorough inspection of all hoses, fittings, and rigid tube lines should be made at least once a month. Any deterioration should be carefully examined and a determination made as to whether further use of the component would constitute a safety hazard. Conditions such as the following should be sufficient reason for consideration of replacement:

(a) Any evidence of hydraulic oil leakage at the surface of the flexible hose or its junction with the metal and couplings.

(b) Any blistering or abnormal deformation to the outer covering of the hydraulic hose.

(c) Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures.

(d) Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fittings. Means shall be taken immediately to eliminate the interference of the elements in contact or otherwise protect the components.

2.1.5 Cab Windows. Windows and/or openings are provided and arranged for visibility of work area and to each side of the operator. All cab windows are of safety glass.

2.1.6 Cab Doors. All cab doors, whether of sliding or swinging type, are adequately restrained from accidental opening or closing while traveling or operating the machine. The door adjacent to the operator, if of the swinging type, opens outward and if of the sliding type, slides rearward to open.

2.1.7 Access. Suitable handholds and/or steps are provided to facilitate entrance to and exit from operator's cab. When necessary for rigging or service requirements, ladders or steps are provided to facilitate access to the cab roof.

2.1.8 Guards for Moving Parts.

(a) Exposed moving parts such as gears, setscrews, projecting keys, chains, chain sprockets, and reciprocating parts which might constitute a hazard under normal operating conditions are guarded.

(b) Guards are securely fastened.

(c) **Each guard is capable of supporting,** without permanent distortion, the weight of a 200-lb man. This requirement is void if the guard is located where it is impossible for a man to step on it.

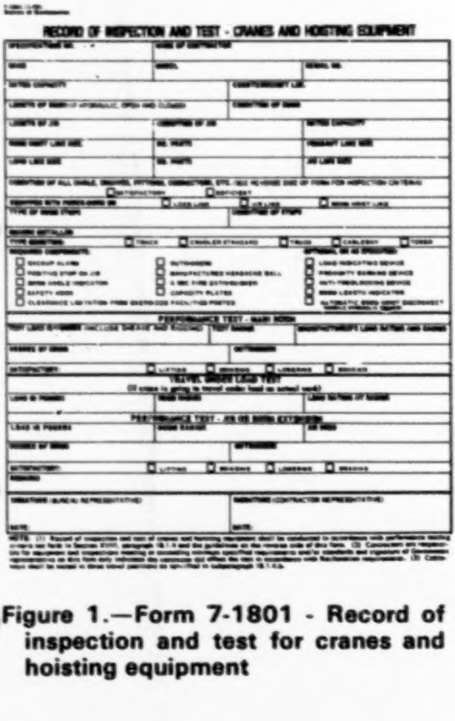
2.1.9 Truck Brakes. Truck-and wheel-mounted cranes have service brakes capable of bringing machine to a stop on level ground within a distance of 32 ft from speed of 15 mi/h, and brakes adequately hold machine stationary on maximum operating grade specified by the manufacturer.

2.1.10 Method to barricade swing radius is provided.

3. Testing Procedure. The crane shall be placed on level ground or railroad tracks if rail type. Outriggers, if provided, will be firmly set and relieve all weight from wheels within the boundary of the outrigger. Owner or contractor shall select a test weight and boom radius that will provide a test load of 110 percent of manufacturer's rating for selected radius. This load will be raised, lowered, and rotated through 360 longitudinal degrees or manufacturer's specified maximum degree of rotation. Cranes equipped with jibs or boom tip extensions will be tested using both the main boom and jib with an appropriate test load in each case. Hydraulic cranes with telescoping booms will be further tested during telescoping operations. Cranes that are to be used in pick-and-carry operations will be tested with a load consistent with owner/contractor's intended operation but never greater than manufacturer's recommendations. The load shall be held for 10 minutes in the raised position, following which critical load bearing parts shall be inspected for damage.

CAUTION: Extreme care should be exercised in determining mobile crane test load. Once manufacturer's rating charts are consulted to determine maximum loading at chosen radius, rigging limitations must be computed to ensure wire rope safety factors are not exceeded. Such determination is made by (1) adding selected load weight to weight of all auxiliary handling devices such as hoist block, hooks, slings, etc., (2) dividing this figure by number of parts of line to obtain hoisting load per single part of line, (3) obtaining manufacturer's specified breaking strength for type of rope being used (i.e., a 3/4-inch Manitoc steel rope of 6-by 35-inch filler wire constructed with Indy wire rope core has a breaking strength of 25.6 tons), (4) dividing breaking strength by safety factor of 3.5 for running ropes or 3.0 for standing or guy ropes. Compare this resultant figure with single part line load to determine if selected load exceeds safe load. If safe load is exceeded, a new weight consistent with calculated line load must be choosen. Note: Calculated safe single part line load multiplied by number parts of line sets the maximum crane load rating under existing rigging conditions regardless of maximum crane rating set by manufacturer.

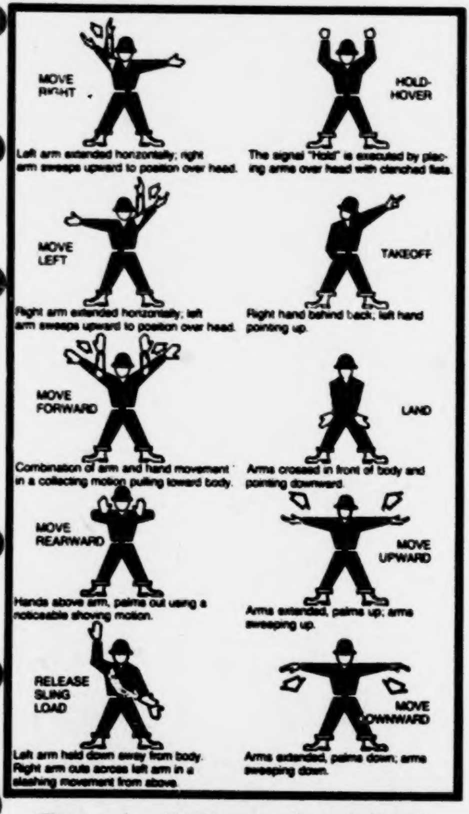
Appendix V (CONTINUED)



RECORD OF INSPECTION AND TEST - CRANES AND HOISTING EQUIPMENT

Figure 1.—Form 7-1801 - Record of inspection and test for cranes and hoisting equipment

Appendix W - HELICOPTER HAND SIGNALS


MOVE RIGHT
HOLD-HOVER
MOVE LEFT
TAKEOFF
MOVE FORWARD
LAND
MOVE REARWARD
MOVE UPWARD
RELEASE SLING LOAD
MOVE DOWNWARD

Left arm extended horizontally; right arm sweeps upward to position over head.

The signal "Hold" is executed by placing arms over head with clenched fists.

Right arm extended horizontally; left arm sweeps upward to position over head.

Right hand behind back; left hand pointing up.

Combination of arm and hand movement in a collecting motion pulling toward body.

Arms crossed in front of body and pointing downward.

Hands above arm, palms out using a noticeable shoving motion.

Arms extended, palms up; arms sweeping up.

Left arm held down away from body. Right arm cuts across left arm in a slashing movement from above.

Arms extended, palms down; arms sweeping down.

Figure 1.—Helicopter hand signals

Appendix X - BRAKE PERFORMANCE TEST RECORD

A. Requirement. Pneumatic-tired, self-propelled, earthmoving equipment shall be equipped with service braking systems, emergency stopping systems, and parking systems in accordance with paragraph 19.6.4 of this manual. The braking systems may use common components; however, a failure of a common component shall not reduce the effectiveness of the vehicle stopping capability below the emergency stopping performance as shown in table 1.

B. Performance test

1. Performance tests are required for equipment described in paragraph 19.6.5.

2. Prior to conducting a brake performance test, the equipment shall be checked to determine whether the braking system complies with the requirements set forth in paragraph 19.6.4.

3. Equipment failing to possess braking systems meeting the criteria stipulated in paragraph 19.6.4 will not be tested nor permitted to operate until the braking system is in full compliance.

C. Stopping test criteria (Loaders, Dumpers, Tractor Scrapers, and Graders)

1. Criteria. The tests shall be conducted as set forth in the following and shall stop and hold the equipment within the distance specified in table 1. (A 10-percent overtravel will be acceptable.)

2. Facilities and instrumentation

a. The test course shall consist of a clean, swept, level, dry concrete, gravel, or other specified surface of adequate length to conduct the test. The braking surface shall not have over 1 percent grade in the direction of travel or more than 3 percent grade at right angles to the direction of travel.

b. Means shall be provided to determine the weight of the equipment, the stopping distance with an accuracy of plus or minus 2 percent, and the test speed with an accuracy of plus or minus 5 percent. Also, a means shall be provided to measure system recovery capability.

3. Test Requirements

a. Tests shall be conducted with the applicable braking system fully charged.

b. Stopping tests shall be conducted under the following conditions:

Loaders	Unloaded with bucket in SAE carry position (SAE J732)
Dumpers and tractor scrapers	Loaded to manufacturer's gross weight rating and distribution
Graders	Cutting edge in transport position
Tractor dozers	Lowest part of cutting edge 18 inches above test surface.

c. Stopping distance to be measured from the point at which the brake is applied to the point at which the equipment is stopped.

d. Each machine shall be tested at the speed indicated in table 1. Both the service brake and emergency braking systems shall be tested.

e. The test shall be conducted with the transmission in the gear commensurate with the speed required. The power train may be disengaged prior to completing the stop.

f. Auxiliary retarders shall not be used in the test unless the retarder is simultaneously actuated by the applicable brake system control.

4. Stopping distances. The required stopping distances for application of service brakes and emergency braking systems are indicated in table 1.

D. Holding performance. The service braking system shall have capability equivalent to holding the vehicle stationary on a 30 percent grade or on the maximum operational grade specified by the manufacturer of the equipment or at the maximum grade the equipment will be operated under all conditions of loading. In no case shall the contractor exceed the manufacturer's rated grade ability for the respective piece of equipment.

E. System recovery. With the vehicle stationary, the service braking system's primary power source shall have the capability of delivering at least 70 percent of maximum system pressure measured at the brakes when the brakes are fully applied 20 times at the rate of 6 applications per minute with the engine at maximum governed revolutions per minute. Off highway truck and wagons, and scrapers, the rate is 3 applications per minute.

F. Warning device. The service braking system using stored energy shall be equipped with a warning device which actuates before the system energy drops below 50 percent of the manufacturer's specified maximum operating energy level. The device shall be readily visible and/or audible to the operator and provide a continuous warning. Gages indicating pressure or vacuum shall not be acceptable to meet these requirements.

G. Emergency brake application. The emergency system shall be capable of being applied by a person seated in the driver's seat. The system shall be arranged so that it cannot be released from the driver's seat after any application unless immediate reapplication can be made from the driver's seat to stop the vehicle or combination of vehicles. In addition to the manual control, the emergency stopping system may also be applied automatically. If an automatic emergency stopping system is used, the automatic application shall occur after the warning device is actuated.

H. Parking system

1. All vehicles shall be equipped with a parking system capable of being applied by a person seated in the driver's seat.

2. The parking system shall hold the vehicle stationary on a 15 percent grade under all conditions of loading. This criterion shall apply to both the forward and reverse directions.

3. The parking system, when applied, shall maintain the parking performance in compliance with subparagraph 3 despite any contraction of the brake parts, exhaustion of the source of energy, or leakage of any kind.

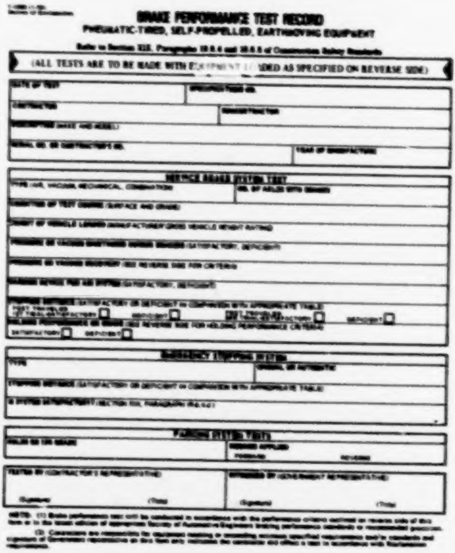
Table 1.—*Brake performance requirements*

Vehicle and test speed	Vehicle weight in pounds	Service brake maximum stopping distance in feet	Emergency system maximum stopping distance in feet
Loaders and tractor dozers 16 mi/h	Up to 36,000	31	93
	36,001-70,000	41	123
	70,001-140,000	50	150
	140,001-280,000	60	180
	Over 280,000	73	219
Dumpers 20 mi/h	Up to 100,000	59	153
	100,001-200,000	74	173
	200,001-400,000	96	202
	Over 400,000	118	231
Combination dumpers and dumper trains 20 mi/h	Up to 100,000	59	153
	100,001-200,000	89	192
	200,001-400,000	125	241
	Over 400,000	177	310

Table 1.—*Brake performance requirements (Continued)*

Tractor scrapers 20 mi/h	Up to 50,000	58	151
	50,001-100,000	73	170
	100,001-150,000	88	190
	Over 150,000	102	209
Graders 18 mi/h	Up to 35,000	35	105
	35,001-70,000	45	135
	Over 70,000	62	186

Appendix X (CONTINUED)



BRAKE PERFORMANCE TEST RECORD

PNEUMATIC-TIRED, SELF-PROPELLED, EARTHMOVING EQUIPMENT

(ALL TESTS ARE TO BE MADE WITH EQUIPMENT LOADED AS SPECIFIED ON REVERSE SIDE)

Figure 1. —Form 7-1920, Brake performance test record.

Appendix Y - TRENCH SHORING - MINIMUM REQUIREMENTS

Table I.—*Minimum requirements for trench shoring*

Depth of trench	Kind of condition of earth	Size and spacing of members										
		Uprights		Stringers		Cross braces[1]						
						Width of trench					Maximum spacing	
		Minimum dimension	Maximum spacing	Minimum dimension	Maximum spacing	Up to 3 feet	3 to 6 feet	6 to 9 feet	9 to 12 feet	12 to 15 feet	Vertical	Horizontal
Feet		Inches	Feet	Inches	Feet	Inches	Inches	Inches	Inches	Inches	Feet	Feet
5 to 10	Hard, compact	3 x 4 or 2 x 6	6			2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	6
	Likely to crack	3 x 4 or 2 x 6	3	4 x 6	4	2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	6
	Soft, sandy, filled	3 x 4 or 2 x 6	Close sheeting	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
	Hydrostatic pressure	3 x 4 or 2 x 6	Close sheeting	6 x 8	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
10 to 15	Hard	3 x 4 or 2 x 6	4	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
	Likely to crack	3 x 4 or 2 x 6	2	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8		6
	Soft, sandy, or filled	3 x 4 or 2 x 6	Close sheeting	4 x 6	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	6
	Hydrostatic pressure	3 x 6	Close sheeting	8 x 10	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	6
15 to 20	All kinds or conditions	3 x 6	Close sheeting	4 x 12	4	4 x 12	6 x 8	8 x 8	8 x 10	10 x 10	4	6
Over 20	All kinds or conditions	3 x 6	Close sheeting	6 x 8	4	4 x 12	8 x 8	8 x 10	10 x 10	10 x 12	4	6

[1] Trench jacks may be used in lieu of, or in combination with, cross braces. Shoring is not required in solid rock, hard shale, or hard slag. Where desirable, steel sheet piling and bracing of equal strength may be substituted for wood.
Dimensions are based on nominal sizes of Douglas fir or equivalent. The greater dimensions of the stringers should be straight angle to the sheeting.

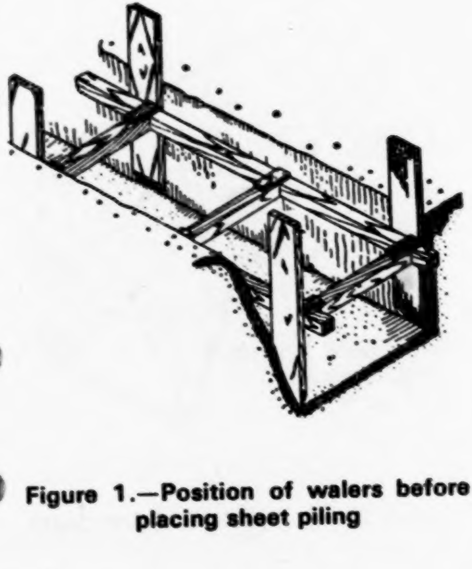
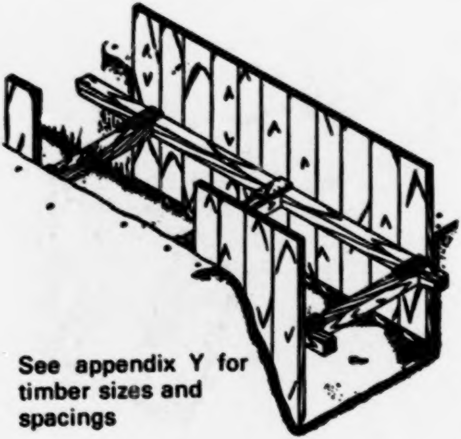


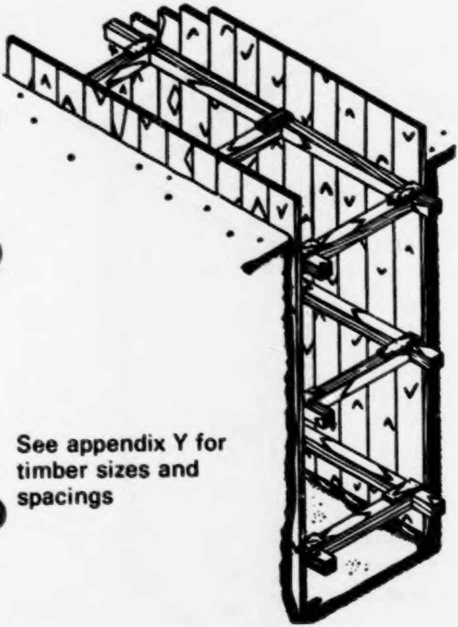
Figure 1.—Position of walers before placing sheet piling



See appendix Y for timber sizes and spacings

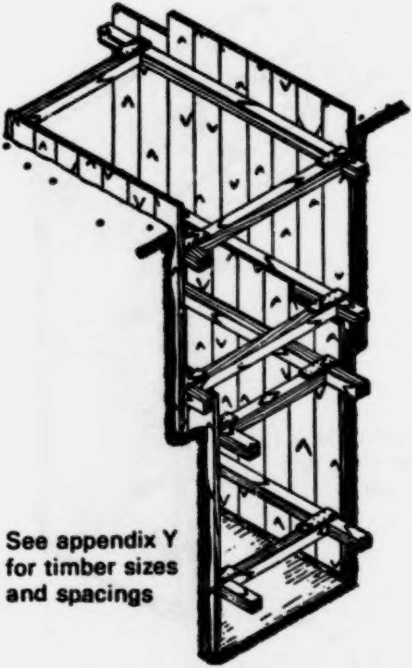
Figure 2.—Completion of first depth

Appendix Z (CONTINUED)



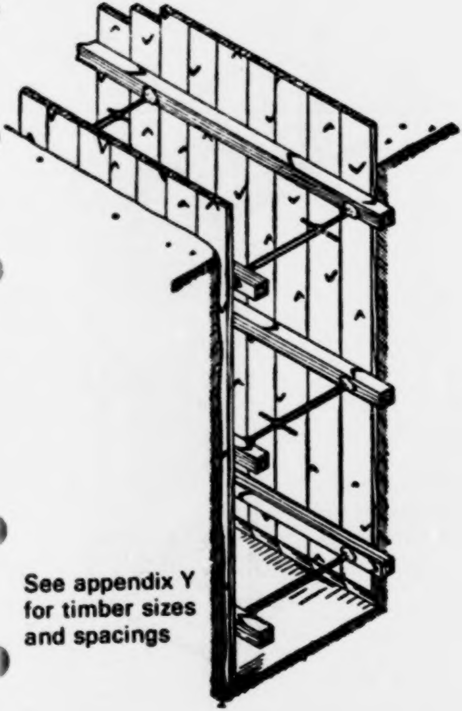
See appendix Y for timber sizes and spacings

Figure 3.—Completed to full depth



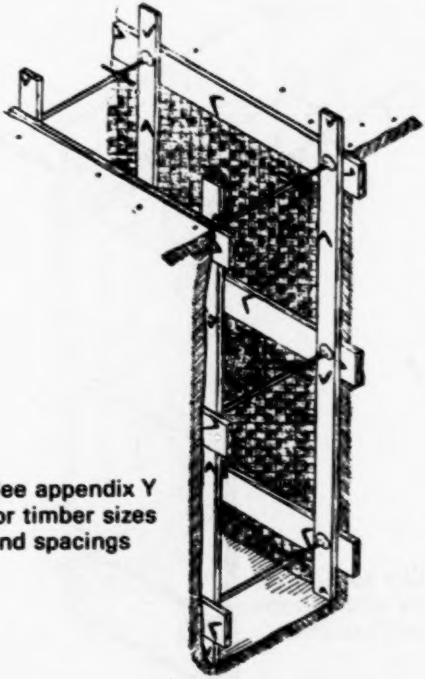
See appendix Y
for timber sizes
and spacings

Figure 4.—Completed to full depth using two lengths of sheeting



See appendix Y for timber sizes and spacings

Figure 5.—Trench jacks substituted for cross bracing



See appendix Y for timber sizes and spacings

Figure 6 - Bracing with trench jacks in hard compact soil

Appendix AA - DISTANCES FOR STORAGE OF EXPLOSIVES

Table 1.—*Distances for storage of explosives*

Explosives		Distances in ft. when storage is barricaded			
Pounds over	Pounds not over	Inhabited Buildings	Passenger railways	Public highways	Separation of Magazines
2	5	70	51	30	6
5	10	90	64	35	8
10	20	110	81	45	10
20	30	125	93	50	11
30	40	140	103	55	12
40	50	150	110	60	14
50	75	170	127	70	15
75	100	190	139	75	16
100	125	200	150	80	18
125	150	215	159	85	19
150	200	235	175	95	21
200	250	255	189	105	23
250	300	270	201	110	24
300	400	295	221	120	27
400	500	320	238	130	29
500	600	340	253	135	31
600	700	355	266	145	32
700	800	375	278	150	33
800	900	390	289	155	35
900	1,000	400	300	160	36
1,000	1,200	425	318	165	39
1,200	1,400	450	336	170	41
1,400	1,600	470	351	175	42

Appendix AA (CONTINUED)

Table 1.—*Distances for storage of explosives (Continued)*

Explosives		Distances in ft. when storage is barricaded			
Pounds over	Pounds not over	Inhabited Buildings	Passenger railways	Public highways	Separation of Magazines
1,600	1,800	490	366	180	44
1,800	2,000	505	378	185	45
2,000	2,500	545	408	190	49
2,500	3,000	580	432	195	52
3,000	4,000	635	474	210	58
4,000	5,000	685	513	225	61
5,000	6,000	730	546	235	65
6,000	7,000	770	573	245	68
7,000	8,000	800	600	250	72
8,000	9,000	835	624	255	75
9,000	10,000	865	645	260	78
10,000	12,000	875	687	270	82
12,000	14,000	885	723	275	87
14,000	16,000	900	756	280	90
16,000	18,000	940	786	285	94
18,000	20,000	975	813	290	98
20,000	25,000	1,055	876	315	105
25,000	30,000	1,130	933	340	112
30,000	35,000	1,205	981	360	119
35,000	40,000	1,275	1,026	380	124
40,000	45,000	1,340	1,068	400	129
45,000	50,000	1,400	1,104	420	135
50,000	55,000	1,460	1,140	440	140
55,000	60,000	1,515	1,173	455	145
60,000	65,000	1,565	1,206	470	150
65,000	70,000	1,610	1,236	485	155
70,000	75,000	1,655	1,263	500	160

Appendix AA (CONTINUED)

Table 1.—*Distances for storage of explosives (Continued)*

Explosives		Distances in ft. when storage is barricaded			
Pounds over	Pounds not over	Inhabited Buildings	Passenger railways	Public highways	Separation of Magazines
75,000	80,000	1,695	1,293	510	165
80,000	85,000	1,730	1,317	520	170
85,000	90,000	1,760	1,344	530	175
90,000	95,000	1,790	1,368	540	180
95,000	100,000	1,815	1,392	545	185
100,000	110,000	1,835	1,437	550	195
110,000	120,000	1,855	1,479	555	205
120,000	130,000	1,875	1,521	560	215
130,000	140,000	1,890	1,357	565	225
140,000	150,000	1,900	1,593	570	235
150,000	160,000	1,935	1,629	580	245
160,000	170,000	1,965	1,662	590	255
170,000	180,000	1,990	1,695	600	265
180,000	190,000	2,010	1,725	605	275
190,000	200,000	2,030	1,755	610	285
200,000	210,000	2,055	1,782	620	295
210,000	230,000	2,100	1,836	635	315
230,000	250,000	2,155	1,890	650	337
250,000	275,000	2,215	1,950	670	360
275,000	300,000	2,275	2,000	690	385

Note 1. "Explosive materials" means explosives, blasting agents, and detonators.

Note 2. "Explosives" means any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. A list of explosives determined to be within the coverage of "18 U.S.C. Chapter 40, Importation, Manufacture, Distribution and Storage of Explosive Materials" is issued annually by the Director of the Alcohol, Tobacco, and Firearms Division.

Note 3. "Blasting agents" means any material or mixture, consisting of fuel and oxidizer, intended for blasting, not otherwise defined as an explosive, provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a number 8 test blasting cap when unconfined.

Note 4. "Detonator" means any device containing a detonating charge that is used for initiating detonation in an explosive. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, and detonating-cord delay connectors.

Note 5. "Magazine" means any building or structure, other than an explosives manufacturing building, used for the permanent storage of explosive materials.

Note 6. "Natural Barricade" means natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the magazine when the trees are bare of leaves.

Note 7. "Artificial Barricade" means an artificial mound or revetted wall of earth with a minimum thickness of three feet.

Note 8. "Barricaded" means that a building containing explosives is effectually screened from a magazine, building, railway, or highway, either by a natural barricade, or by an artificial barricade of such height that a straight line from the top of any sidewall of the building containing explosives to the eave line of any magazine, or building, or to a point above the center of a railway or highway, will pass through such intervening natural or artificial barricade.

Note 9. "Inhabited Building Distance" is the minimum allowable separation between explosive storage areas and public/private places of residence or assembly, commercial facilities and utilities, recreational facilities, project visitor areas, and Government and contractor work and storage areas or places where workers gather, whether indoors or outdoors.

Note 10. "Railway" means any steam, electric, or other railroad or railway which carries passengers for hire.

Note 11. "Highway" means any street or public road. "Public Highways Class A to D" are highways with average traffic volume of 3,000 or less vehicles per day as specified in "American Civil Engineering Practice" (Abbett, Vol. 1, Table 46, Sec. 3-74, 1956 Edition, John Wiley and Sons).

Note 12. When two or more storage magazines are located on the same property, each magazine must comply with the minimum distances specified from inhabited buildings, railways, and highways, and, in addition, they should be separated from each other by not less than the distances shown for "Separation of Magazines," except that the quantity of explosives contained in cap magazines shall govern in regard to the spacing of said cap magazines from magazines containing other explosives. If any two or more magazines are separated from each other by less than the specified "Separation of Magazines" distances, then such two or more magazines, as a group, must be considered as one magazine, and the total quantity of explosives stored in such group must be treated as if stored in a single magazine located on the site of any magazine of the group, and must comply with the minimum distances specified from other magazines, inhabited buildings, railways, and highways.

Note 13. Storage in excess of 300,000 lbs. of explosives in one magazine is prohibited.

Appendix AA (CONTINUED)

Note 14. This table is not applicable to transportation of explosives or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles, or other heavily encased explosives.

For transportation purposes, the Department of Transportation in Title 49 Transportation CFR Parts 1-199 subdivides explosives into three classes:

Class A — Maximum Hazard
Class B — Flammable Hazard
Class C — Minimum Hazard

Note 15. All types of blasting caps in strengths through No. 8 cap should be rated at 1½ lbs. of explosives per 1,000 caps. For strengths higher than No. 8 cap, consult the manufacturer.

Note 16. For quantity and distance purposes, detonating cord of 50 or 60 grains per foot should be calculated as equivalent to 9 lbs. of high explosives per 1,000 feet. Heavier or lighter core loads should be rated proportionately.

Note 17. When a building containing explosives is not barricaded, the distance shown in the above tables should be doubled.

Note 18. These tables are for minimum distances applicable to any human exposed to explosive hazards on or off Government owned property.

Appendix AA (CONTINUED)

Table 2.—*Recommended separation distances of ammonium nitrate and blasting agents from explosives or blasting agents*[1]

References — NFPA No. 492 & NFPA No. 495

Donor Weight		Minimum Separation Distance of Receptor when Barricaded[2] (ft.)		Minimum Thickness of Artifical Barricades[5] (in.)
Pounds Over	Pounds Not Over	Ammonium Nitrate[3]	Blasting Agent[4]	
	100	3	11	12
100	300	4	14	12
300	600	5	18	12
600	1,000	6	22	12
1,000	1,600	7	25	12
1,600	2,000	8	29	12
2,000	3,000	9	32	15
3,000	4,000	10	36	15
4,000	6,000	11	40	15
6,000	8,000	12	43	20
8,000	10,000	13	47	20
10,000	12,000	14	50	20
12,000	16,000	15	54	25
16,000	20,000	16	58	25
20,000	25,000	18	65	25
25,000	30,000	19	68	30
30,000	35,000	20	72	30
35,000	40,000	21	76	30
40,000	45,000	22	79	35
45,000	50,000	23	83	35
50,000	55,000	24	86	35
55,000	60,000	25	90	35
60,000	70,000	26	94	40
70,000	80,000	28	101	40
80,000	90,000	30	108	40
90,000	100,000	32	115	40
100,000	120,000	34	122	50
120,000	140,000	37	133	50
140,000	160,000	40	144	50
160,000	180,000	44	158	50
180,000	200,000	48	173	50
200,000	220,000	52	187	60
220,000	250,000	56	202	60
250,000	275,000	60	216	60
275,000	300,000	64	230	60

Appendix AA (CONTINUED)

Note 1. Recommended separation distances to prevent explosion of ammonium nitrate and ammonium nitrate-based blasting agents by propagation from nearby stores of high explosives or blasting agents referred to in the table as the "donor." Ammonium nitrate, by itself, is not considered to be a donor when applying this table. Ammonium nitrate, ammonium nitrate-fuel oil or combinations thereof are acceptors. If stores of ammonium nitrate are located within the sympathetic detonation distance of explosives or blasting agents, one-half the mass of the ammonium nitrate should be included in the mass of the donor.

The distances apply to the separation of stores only. The "Table of Distances" shall be used in determining separation distances from inhabited buildings, passenger railways and public highways.

Note 2. When the ammonium nitrate and/or blasting agent is not barricaded, the distances shown in the table shall be multiplied by six. These distances allow for the possibility of high velocity metal fragments from mixers, hoppers, truck bodies, sheet metal structures, metal containers, and the like which may enclose the "donor." Where storage is in bullet-resistant magazines* recommended for explosives or where the storage is protected by a bullet-resistant wall, distances and barricade thicknesses in excess of those prescribed in the "Table of Distances" are not required.

Note 3. The distances in the table apply to ammonium nitrate that passes the insensitivity test prescribed in the definition of ammonium nitrate fertilizer promulgated by the National Plant Food Institute;† and ammonium nitrate failing to pass said test shall be stored at separation distances determined by competent persons and approved by the authority having jurisdiction.

Note 4. The distances referred to in Note 3 apply to nitro-carbo-nitrates and blasting agents which pass the insensitivity test prescribed in the U.S. Department of Transportation (DOT) regulations.

Note 5. Earth, or sand dikes, or enclosures filled with the prescribed minimum thickness of earth or sand are acceptable artificial barricades. Natural barricades, such as hills or timber of sufficient density that the surrounding exposures, which require protection, cannot be seen from the "donor" when the trees are bare of leaves, are also acceptable.

Note 6. When the ammonium nitrate must be counted in determining the distances to be maintained from inhabited buildings, passenger railways and public highways, it may be counted at one-half its actual weight because its blast effect is lower.

•For construction of bullet-resistant magazines, see IME Publication No. 1.

†Definition and Test Procedures for Ammonium Nitrate, Fertilizer, National Plant Food Institute, November 1964.

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Appendix BB - RATED CAPACITIES FOR ROPES, CHAINS, AND SLINGS

Table 1.—*Rated capacity (working load limit) for alloy steel chain slings-rated capacity (working load limit), pounds*

Chain Size, inches	Single Branch Sling – 90 degree Loading	Double Sling			Triple and Quadruple Sling		
		Vertical Angle (1) 30 degree	Vertical Angle (1) 45 degree	Vertical Angle (1) 60 degree	Vertical Angle (1) 30 degree	Vertical Angle (1) 45 degree	Vertical Angle (1) 60 degree
		Horizontal Angle (2) 60 degree	Horizontal Angle (2) 45 degree	Horizontal Angle (2) 30 degree	Horizontal Angle (2) 60 degree	Horizontal Angle (2) 45 degree	Horizontal Angle (2) 30 degree
1/4	3,250	5,560	4,550	3,250	8,400	6,800	4,900
3/8	6,600	11,400	9,300	6,600	17,000	14,000	9,900
1/2	11,250	19,500	15,900	11,250	29,000	24,000	17,000
5/8	16,500	28,500	23,300	16,500	43,000	35,000	24,500
3/4	23,000	39,800	32,500	23,000	59,500	48,500	34,500
7/8	28,750	49,800	40,600	28,750	74,500	61,000	43,000
1	38,750	67,100	54,800	38,750	101,000	82,000	58,000
1-1/8	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1-1/4	57,500	99,500	81,000	57,500	149,000	121,500	86,000
1-3/8	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1-1/2	80,000	138,000	112,500	80,000	207,000	169,000	119,500
1-3/4	100,000	172,000	140,000	100,000	258,000	210,000	150,000

(1) Rating of multileg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical.

(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load.

*Other grades of proof tested steel chain include Proof Coil, BBB Coil and Hi-Test Chain. These grades are not recommended for overhead lifting and therefore are not covered by this code.

Appendix BB (CONTINUED)

Table 2.—*Maximum allowable wear at any point of link*

Chain size (inches)	*Maximum allowable wear (inch)*
1/4	3/64
3/8	5/64
1/2	7/64
5/8	9/64
3/4	5/32
7/8	11/64
1	3/16
1 1/8	7/32
1 1/4	1/4
1 3/8	9/32
1 1/2	5/16
1 3/4	11/32

Table 3.—*Rated capacities for single leg slings 6 x 19 and 6 x 37 classification improved plow steel grade rope with fiber core (FC)*

Rope		Rated Capacities, Tons (2,000 lb)								
		Vertical			Choker			Vertical Basket*		
Dia (Inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
1/4	6 × 19	0.49	0.51	0.55	0.37	0.38	0.41	0.99	1.0	1.1
5/16	6 × 19	0.76	0.79	0.85	0.57	0.59	0.64	1.5	1.6	1.7
3/8	6 × 19	1.1	1.1	1.2	0.80	0.85	0.91	2.1	2.2	2.4
7/16	6 × 19	1.4	1.5	1.6	1.1	1.1	1.2	2.9	3.0	3.3
1/2	6 × 19	1.8	2.0	2.1	1.4	1.5	1.6	3.7	3.9	4.3
9/16	6 × 19	2.3	2.5	2.7	1.7	1.9	2.0	4.6	5.0	5.4
5/8	6 × 19	2.8	3.1	3.3	2.1	2.3	2.5	5.6	6.2	6.7
3/4	6 × 19	3.9	4.4	4.8	2.9	3.3	3.6	7.8	8.8	9.5
7/8	6 × 19	5.1	5.9	6.4	3.9	4.5	4.8	10.0	12.0	13.0
1	6 × 19	6.7	7.7	8.4	5.0	5.8	6.3	13.0	15.0	17.0
1-1/8	6 × 19	8.4	9.5	10.0	6.3	7.1	7.9	17.0	19.0	21.0
1-1/4	6 × 37	9.8	11.0	12.0	7.4	8.3	9.2	20.0	22.0	25.0
1-3/8	6 × 37	12.0	13.0	15.0	8.9	10.0	11.0	24.0	27.0	30.0
1-1/2	6 × 37	14.0	16.0	17.0	10.0	12.0	13.0	28.0	32.0	35.0
1-5/8	6 × 37	16.0	18.0	21.0	12.0	14.0	15.0	33.0	37.0	41.0
1-3/4	6 × 37	19.0	21.0	24.0	14.0	16.0	18.0	38.0	43.0	48.0
2	6 × 37	25.0	28.0	31.0	18.0	21.0	23.0	49.0	55.0	62.0

HT = Hand Tucked Splice and Hidden Tuck Splice
For hidden tuck splice (IWRC) use values in HT columns.
MS = Mechanical Splice
S = Swaged or Zinc Poured Socket
*These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S slings is 20 or greater where:
D = Diameter of curvature around which the body of the sling is bent.
d = Diameter of rope.

Appendix BB (CONTINUED)

Table 4.—*Rated capacities for single leg slings 6 x 19 and 6 x 37 classification improved plow steel grade rope with independent wire rope core (IWRC)*

Rope		Rated Capacities, Tons (2,000 lb)								
		Vertical			Choker			Vertical Basket*		
Dia (Inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
1/4	6 x 19	0.53	0.56	0.59	0.40	0.42	0.44	1.0	1.1	1.2
5/16	6 x 19	0.81	0.87	0.92	0.61	0.65	0.69	1.6	1.7	1.8
3/8	6 x 19	1.1	1.2	1.3	0.86	0.93	0.98	2.3	2.5	2.6
7/16	6 x 19	1.5	1.7	1.8	1.2	1.3	1.3	3.1	3.4	3.5
1/2	6 x 19	2.0	2.2	2.3	1.5	1.6	1.7	3.9	4.4	4.6
9/16	6 x 19	2.5	2.7	2.9	1.8	2.1	2.2	4.9	5.5	5.8
5/8	6 x 19	3.0	3.4	3.6	2.2	2.5	2.7	6.0	6.8	7.2
3/4	6 x 19	4.2	4.9	5.1	3.1	3.6	3.8	8.4	9.7	10.0
7/8	6 x 19	5.5	6.6	6.9	4.1	4.9	5.2	11.0	13.0	14.0
1	6 x 19	7.2	8.5	9.0	5.4	6.4	6.7	14.0	17.0	18.0
1-1/8	6 x 19	9.0	10.0	11.0	6.8	7.8	8.5	18.0	21.0	23.0
1-1/4	6 x 37	10.0	12.0	13.0	7.9	9.2	9.9	21.0	24.0	26.0
1-3/8	6 x 37	13.0	15.0	16.0	9.6	11.0	12.0	25.0	29.0	32.0
1-1/2	6 x 37	15.0	17.0	19.0	11.0	13.0	14.0	30.0	35.0	38.0
1-5/8	6 x 37	18.0	20.0	22.0	13.0	15.0	17.0	35.0	41.0	44.0
1-3/4	6 x 37	20.0	24.0	26.0	15.0	18.0	19.0	41.0	47.0	51.0
2	6 x 37	26.0	30.0	33.0	20.0	23.0	25.0	53.0	61.0	66.0

HT – Hand Tucked Splice
For hidden tuck splice (IWRC) use Table H-3 values in HT column.
MS Mechanical Splice.
S Swaged or Zinc Poured Socket.

*These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S Slings is 20 or greater where
D – Diameter of curvature around which the body of the sling is bent.
d = Diameter of rope.

Appendix BB (CONTINUED)

Table 5. —*Rated capacities for single leg slings cable laid rope - mechanical splice only 7 x 7 x 7 and 7 x 7 x 19 constructions galvanized aircraft grade rope 7 x 6 x 19 IWRC construction improved plow steel grade rope*

Rope		Rated Capacities, Tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical Basket*
1/4	7 x 7 x 7	0.50	0.38	1.0
3/8	7 x 7 x 7	1.1	0.81	2.2
1/2	7 x 7 x 7	1.8	1.4	3.7
5/8	7 x 7 x 7	2.8	2.1	5.5
3/4	7 x 7 x 7	3.8	2.9	7.6
5/8	7 x 7 x 19	2.9	2.2	5.8
3/4	7 x 7 x 19	4.1	3.0	8.1
7/8	7 x 7 x 19	5.4	4.0	11.0
1	7 x 7 x 19	6.9	5.1	14.0
1-1/8	7 x 7 x 19	8.2	6.2	16.0
1-1/4	7 x 7 x 19	9.9	7.4	20.0
3/4	7 x 6 x 19 IWRC	3.8	2.8	7.6
7/8	7 x 6 x 19 IWRC	5.0	3.8	10.0
1	7 x 6 x 19 IWRC	6.4	4.8	13.0
1-1/8	7 x 6 x 19 IWRC	7.7	5.8	15.0
1-1/4	7 x 6 x 19 IWRC	9.2	6.9	18.0
1-5/16	7 x 6 x 19 IWRC	10.0	7.5	20.0
1-3/8	7 x 6 x 19 IWRC	11.0	8.2	22.0
1-1/2	7 x 6 x 19 IWRC	13.0	9.8	26.0

*These values only apply when the D/d ratio is 10 or greater where:

D = Diameter of curvature around which the body of the sling is bent.

d = Diameter of rope.

Appendix BB (CONTINUED)

Table 6.—*Rated capacities for single leg slings 8-part and 6-part braided rope 6 x 7 and 6 x 19 construction improved plow steel grade rope 7 x 7 construction galvanized aircraft grade rope*

Component Ropes		Rated Capacities, Tons (2,000 lb)					
		Vertical		Choker		Basket Vertical to 30 degrees*	
Diameter (Inches)	Constr	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6 × 7	0.42	0.32	0.32	0.24	0.74	0.55
1/8	6 × 7	0.76	0.57	0.57	0.42	1.3	0.98
3/16	6 × 7	1.7	1.3	1.3	0.94	2.9	2.2
3/32	7 × 7	0.51	0.39	0.38	0.29	0.89	0.67
1/8	7 × 7	0.95	0.71	0.71	0.53	1.6	1.2
3/16	7 × 7	2.1	1.5	1.5	1.2	3.6	2.7
3/16	6 × 19	1.7	1.3	1.3	0.98	3.0	2.2
1/4	6 × 19	3.1	2.3	2.3	1.7	5.3	4.0
5/16	6 × 19	4.8	3.6	3.6	2.7	8.3	6.2
3/8	6 × 19	6.8	5.1	5.1	3.8	12.0	8.9
7/16	6 × 19	9.3	6.9	6.9	5.2	16.0	12.0
1/2	6 × 19	12.0	9.0	9.0	6.7	21.0	15.0
9/16	6 × 19	15.0	11.0	11.0	8.5	26.0	20.0
5/8	6 × 19	19.0	14.0	14.0	10.0	32.0	24.0
3/4	6 × 19	27.0	20.0	20.0	15.0	46.0	35.0
7/8	6 × 19	36.0	27.0	27.0	20.0	62.0	47.0
1	6 × 19	47.0	35.0	35.0	26.0	81.0	61.0

*These values only apply when the D/d ratio is 20 or greater where

D = Diameter of curvature around which the body of the sling is bent.

d = Diameter of component rope.

Appendix BB (CONTINUED)

Table 7.—*Rated capacities for 2-leg and 3-leg bridle slings 6 x 19 and 6 x 37 classification improved plow steel grade rope with fiber core (FC)*

Rope		Rated Capacities, Tons (2,000 lb)											
		2-Leg Bridle Slings						3-Leg Bridle Slings					
Dia (Inches)	Constr	Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree		Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree	
		HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
1/4	6 x 19	0.85	0.88	0.70	0.72	0.49	0.51	1.3	1.3	1.0	1.1	0.74	0.7
5/16	6 x 19	1.3	1.4	1.1	1.1	0.76	0.79	2.0	2.0	1.6	1.7	1.1	1.2
3/8	6 x 19	1.8	1.9	1.5	1.6	1.1	1.1	2.8	2.9	2.3	2.4	1.6	1.7
7/16	6 x 19	2.5	2.6	2.0	2.2	1.4	1.5	3.7	4.0	3.0	3.2	2.1	2.3
1/2	6 x 19	3.2	3.4	2.6	2.8	1.8	2.0	4.8	5.1	3.9	4.2	2.8	3.0
9/16	6 x 19	4.0	4.3	3.2	3.5	2.3	2.5	6.0	6.5	4.9	5.3	3.4	3.7
5/8	6 x 19	4.8	5.3	4.0	4.4	2.8	3.1	7.3	8.0	5.9	6.5	4.2	4.6
3/4	6 x 19	6.8	7.6	5.5	6.2	3.9	4.4	10.0	11.0	8.3	9.3	5.8	6.6
7/8	6 x 19	8.9	10.0	7.3	8.4	5.1	5.9	13.0	15.0	11.0	13.0	7.7	8.9
1	6 x 19	11.0	13.0	9.4	11.0	6.7	7.7	17.0	20.0	14.0	16.0	10.0	11.0
1-1/8	6 x 19	14.0	16.0	12.0	13.0	8.4	9.5	22.0	24.0	18.0	20.0	13.0	14.0
1-1/4	6 x 37	17.0	19.0	14.0	16.0	9.8	11.0	25.0	29.0	21.0	23.0	15.0	17.0
1-3/8	6 x 37	20.0	23.0	17.0	19.0	12.0	13.0	31.0	35.0	25.0	28.0	18.0	20.0
1-1/2	6 x 37	24.0	27.0	20.0	22.0	14.0	16.0	36.0	41.0	30.0	33.0	21.0	24.0
1-5/8	6 x 37	28.0	32.0	23.0	26.0	16.0	18.0	43.0	48.0	35.0	39.0	25.0	28.0
1-3/4	6 x 37	33.0	37.0	27.0	30.0	19.0	21.0	49.0	56.0	40.0	45.0	28.0	32.0
2	6 x 37	43.0	48.0	35.0	39.0	25.0	28.0	64.0	72.0	52.0	59.0	37.0	41.0

HT = Hand Tucked Splice.
MS = Mechanical Splice

Table 8.—*Rated capacities for 2-leg and 3-leg bridle slings 6 x 19 and 6 x 37 classification improved plow steel grade rope with independent wire rope core (IWRC)*

Rope		Rated Capacities, Tons (2,000 lb)											
		2-Leg Bridle Sling						3-Leg Bridle Sling					
Dia (Inches)	Constr	Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree		Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree	
		HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
1/4	6 x 19	0.92	0.97	0.75	0.79	0.53	0.56	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6 x 19	1.4	1.5	1.1	1.2	1.81	0.87	2.1	2.3	1.7	1.8	1.2	1.3
3/8	6 x 19	2.0	2.1	1.6	1.8	1.1	1.2	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6 x 19	2.7	2.9	2.2	2.4	1.5	1.7	4.0	4.4	3.3	3.6	2.3	2.5
1/2	6 x 19	3.4	3.8	2.8	3.1	2.0	2.2	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6 x 19	4.3	4.8	3.5	3.9	2.5	2.7	6.4	7.1	5.2	5.8	3.7	4.1
5/8	6 x 19	5.2	5.9	4.2	4.8	3.0	3.4	7.8	8.8	6.4	7.2	4.5	5.1
3/4	6 x 19	7.3	8.4	5.9	6.9	4.2	4.9	11.0	13.0	8.9	10.0	6.3	7.3
7/8	6 x 19	9.6	11.0	7.8	9.3	5.5	6.6	14.0	17.0	12.0	14.0	8.3	9.9
1	6 x 19	12.0	15.0	10.0	12.0	7.2	8.5	19.0	22.0	15.0	18.0	11.0	13.0
1-1/8	6 x 19	16.0	18.0	13.0	15.0	9.0	10.0	23.0	27.0	19.0	22.0	13.0	16.0
1-1/4	6 x 37	18.0	21.0	15.0	17.0	10.0	12.0	27.0	32.0	22.0	26.0	16.0	18.0
1-3/8	6 x 37	22.0	25.0	18.0	21.0	13.0	15.0	33.0	38.0	27.0	31.0	19.0	22.0
1-1/2	6 x 37	26.0	30.0	21.0	25.0	15.0	17.0	39.0	45.0	32.0	37.0	23.0	26.0
1-5/8	6 x 37	31.0	35.0	25.0	29.0	18.0	20.0	46.0	53.0	38.0	43.0	27.0	31.0
1-3/4	6 x 37	35.0	41.0	29.0	33.0	20.0	24.0	53.0	61.0	43.0	50.0	31.0	35.0
2	6 x 37	46.0	53.0	37.0	43.0	26.0	30.0	68.0	79.0	56.0	65.0	40.0	46.0

HT = Hand Tucked Splice
MS = Mechanical Splice

Table 9.—*Rated capacities for 2-leg and 3-leg bridle slings cable laid rope - mechanical splice only 7 x 7 x 7 and 7 x 7 x 19 constructions galvanized aircraft grade rope 7 x 6 x 19 IWRC construction improved plow steel grade rope*

Rope		Rated Capacities, Tons (2,000 lb)					
		2-Leg Bridle Sling			3-Leg Bridle Sling		
Dia (Inches)	Constr	Vert 30 deg Hors 60 deg	45 degree Angle	Vert 60 deg Hors 30 deg	Vert 30 deg Hors 60 deg	45 degree Angle	Vert 60 deg Hors 30 deg
1/4	7 × 7 × 7	0.87	0.71	0.50	1.3	1.1	0.75
3/8	7 × 7 × 7	1.9	1.5	1.1	2.8	2.3	1.6
1/2	7 × 7 × 7	3.2	2.6	1.8	4.8	3.9	2.8
5/8	7 × 7 × 7	4.8	3.9	2.8	7.2	5.9	4.2
3/4	7 × 7 × 7	6.6	5.4	3.8	9.9	8.1	5.7
5/8	7 × 7 × 19	5.0	4.1	2.9	7.5	6.1	4.3
3/4	7 × 7 × 19	7.0	5.7	4.1	10.0	8.6	6.1
7/8	7 × 7 × 19	9.3	7.6	5.4	14.0	11.0	8.1
1	7 × 7 × 19	12.0	9.7	6.9	18.0	14.0	10.0
1-1/8	7 × 7 × 19	14.0	12.0	8.2	21.0	17.0	12.0
1-1/4	7 × 7 × 19	17.0	14.0	9.9	26.0	21.0	15.0
3/4	7×6×19 IWRC	6.6	5.4	3.8	9.9	8.0	5.7
7/8	7×6×19 IWRC	8.7	7.1	5.0	13.0	11.0	7.5
1	7×6×19 IWRC	11.0	9.0	6.4	17.0	13.0	9.6
1-1/8	7×6×19 IWRC	13.0	11.0	7.7	20.0	16.0	11.0
1-1/4	7×6×19 IWRC	16.0	13.0	9.2	24.0	20.0	14.0
1-5/16	7×6×19 IWRC	17.0	14.0	10.0	26.0	21.0	15.0
1-3/8	7×6×19 IWRC	19.0	15.0	11.0	28.3	23.0	16.0
1-1/2	7×6×19 IWRC	22.0	18.0	13.0	33.0	27.0	19.0

Table 10.—*Rated capacities for 2-leg and 3-leg bridle slings 8-part and 6-part braided rope 6 x 7 and 6 x 19 construction improved plow steel grade rope 7 x 7 construction galvanized aircraft grade rope*

Component Rope		Rated Capacities, Tons (2,000 lb)											
		2-Leg Bridle Slings						3-Leg Bridle Slings					
		Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree		Vert 30 degree Horz 60 degree		45 degree Angle		Vert 60 degree Horz 30 degree	
Dia (inches)	Constr	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6 × 7	0.74	0.55	0.60	0.45	0.42	0.32	1.1	0.83	0.90	0.68	0.64	0.48
1/8	6 × 7	1.3	0.98	1.1	0.80	0.76	0.57	2.0	1.5	1.6	1.2	1.1	0.85
3/16	6 × 7	2.9	2.2	2.4	1.8	1.7	1.3	4.4	3.3	3.6	2.7	2.5	1.9
3/32	7 × 7	0.89	0.67	0.72	0.55	0.51	0.39	1.3	1.0	1.1	0.82	0.77	0.58
1/8	7 × 7	1.6	1.2	1.3	1.0	0.95	0.71	2.5	1.8	2.0	1.5	1.4	1.1
3/16	7 × 7	3.6	2.7	2.9	2.2	2.1	1.5	5.4	4.0	4.4	3.3	3.1	2.3
3/16	6 × 19	3.0	2.2	2.4	1.8	1.7	1.3	4.5	3.4	3.7	2.8	2.6	1.9
1/4	6 × 19	5.3	4.0	4.3	3.2	3.1	2.3	8.0	6.0	6.5	4.9	4.6	3.4
5/16	6 × 19	8.3	6.2	6.7	5.0	4.8	3.6	12.0	9.3	10.0	7.6	7.1	5.4
3/8	6 × 19	12.0	8.9	9.7	7.2	6.8	5.1	18.0	13.0	14.0	11.0	10.0	7.7
7/16	6 × 19	16.0	12.0	13.0	9.8	9.3	6.9	24.0	18.0	20.0	15.0	14.0	10.0
1/2	6 × 19	21.0	15.0	17.0	13.0	12.0	9.0	31.0	23.0	25.0	19.0	18.0	13.0
9/16	6 × 19	26.0	20.0	21.0	16.0	15.0	11.0	39.0	29.0	32.0	24.0	23.0	17.0
5/8	6 × 19	32.0	24.0	26.0	20.0	19.0	14.0	48.0	36.0	40.0	30.0	28.0	21.0
3/4	6 × 19	46.0	35.0	38.0	28.0	27.0	20.0	69.0	52.0	56.0	42.0	40.0	30.0
7/8	6 × 19	62.0	47.0	51.0	38.0	36.0	27.0	94.0	70.0	76.0	57.0	54.0	40.0
1	6 × 19	81.0	61.0	66.0	50.0	47.0	35.0	22.0	91.0	99.0	74.0	70.0	53.0

Table 11.—*Rated capacities for strand laid grommet - hand tucked improved plow steel grade rope*

ROPE BODY		RATED CAPACITIES, TONS (2,000 lb)		
Dia (Inches)	Constr	Vertical	Choker	Vertical Basket*
1/4	7 × 19	0.85	0.64	1.7
5/16	7 × 19	1.3	1.0	2.6
3/8	7 × 19	1.9	1.4	3.8
7/16	7 × 19	2.6	1.9	5.2
1/2	7 × 19	3.3	2.5	6.7
9/16	7 × 19	4.2	3.1	8.4
5/8	7 × 19	5.2	3.9	10.00
3/4	7 × 19	7.4	5.6	15.0
7/8	7 × 19	10.0	7.5	20.0
1	7 × 19	13.0	9.7	26.0
1-1/8	7 × 19	16.0	12.0	32.0
1-1/4	7 × 37	18.0	14.0	37.0
1-3/8	7 × 37	22.0	16.0	44.0
1-1/2	7 × 37	26.0	19.0	52.0

*These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which rope is bent.
d = Diameter of rope body.

Table 12.—*Rated capacities for cable laid grommet - hand tucked 7 x 6 x 7 and 7 x 6 x 19 constructions improved plow steel grade rope 7 x 7 x 7 construction galvanized aircraft grade rope*

CABLE BODY		RATED CAPACITIES, TONS (2,000 lb)		
Dia (Inches)	Constr	Vertical	Choker	Vertical Basket*
3/8	7 × 6 × 7	1.3	0.95	2.5
9/16	7 × 6 × 7	2.8	2.1	5.6
5/8	7 × 6 × 7	3.8	2.8	7.6
3/8	7 × 7 × 7	1.6	1.2	3.2
9/16	7 × 7 × 7	3.5	2.6	6.9
5/8	7 × 7 × 7	4.5	3.4	9.0
5/8	7 × 6 × 19	3.9	3.0	7.9
3/4	7 × 6 × 19	5.1	3.8	10.0
15/16	7 × 6 × 19	7.9	5.9	16.0
1-1/8	7 × 6 × 19	11.0	8.4	22.0
1-5/16	7 × 6 × 19	15.0	11.0	30.0
1-1/2	7 × 6 × 19	19.0	14.0	39.0
1-11/16	7 × 6 × 19	24.0	18.0	49.0
1-7/8	7 × 6 × 19	30.0	22.0	60.0
2-1/4	7 × 6 × 19	42.0	31.0	84.0
2-5/8	7 × 6 × 19	56.0	42.0	112.0

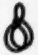
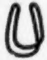
*These values only apply when the D/d value is 5 or greater where:
[illegible] = Diameter [illegible] curvature around which cab[illegible]ody is bent.
d = Diameter of cable body.

Table 13.—*Rated capacities for strand laid endless slings-mechanical joint improved plow steel grade rope*

ROPE BODY		RATED CAPACITIES, TONS (2,000 lb)		
Dia (Inches)	Constr	Vertical	Choker	Vertical Basket*
1/4	6 × 19 IWRC	0.92	0.69	1.8
3/8	6 × 19 IWRC	2.0	1.5	4.1
1/2	6 × 19 IWRC	3.6	2.7	7.2
5/8	6 × 19 IWRC	5.6	4.2	11.0
3/4	6 × 19 IWRC	8.0	6.0	16.0
7/8	6 × 19 IWRC	11.0	8.1	21.0
1	6 × 19 IWRC	14.0	10.0	28.0
1-1/8	6 × 19 IWRC	18.0	13.0	35.0
1-1/4	6 × 37 IWRC	21.0	15.0	41.0
1-3/8	6 × 37 IWRC	25.0	19.0	50.0
1-1/2	6 × 37 IWRC	29.0	22.0	59.0

**These values only apply when the D/d ratio is 5 or greater where:*
D = Diameter of curvature around which rope is bent.
d = Diameter of rope body.

Table 14.—*Rated capacities for cable laid endless slings-mechanical joint 7 x 7 x 7 and 7 x 7 x 19 constructions galvanized aircraft grade rope 7 x 6 x 19 IWRC construction improved plow steel grade rope*

CABLE BODY		RATED CAPACITIES, TONS (2,000 lb)		
Dia (Inches)	Constr	Vertical	 Choker	 Vertical Basket*
1/4	7 × 7 × 7	0.83	0.62	1.6
3/8	7 × 7 × 7	1.8	1.3	3.5
1/2	7 × 7 × 7	3.0	2.3	6.1
5/8	7 × 7 × 7	4.5	3.4	9.1
3/4	7 × 7 × 7	6.3	4.7	12.0
5/8	7 × 7 × 19	4.7	3.5	9.5
3/4	7 × 7 × 19	6.7	5.0	13.0
7/8	7 × 7 × 19	8.9	6.6	18.0
1	7 × 7 × 19	11.0	8.5	22.0
1-1/8	7 × 7 × 19	14.0	10.0	28.0
1-1/4	7 × 7 × 19	17.0	12.0	33.0
3/4	7 × 6 × 19 IWRC	6.2	4.7	12.0
7/8	7 × 6 × 19 IWRC	8.3	6.2	16.0
1	7 × 6 × 19 IWRC	10.0	7.9	21.0
1-1/8	7 × 6 × 19 IWRC	13.0	9.7	26.0
1-1/4	7 × 6 × 19 IWRC	16.0	12.0	31.0
1-3/8	7 × 6 × 19 IWRC	18.0	14.0	37.0
1-1/2	7 × 6 × 19 IWRC	22.0	16.0	43.0

*These values only apply when the D/d ratio is 5 or greater where:
[illegible] = Diameter [illegible] curvature around which cab[illegible]ody is bent.
d = Diameter of cable body.

Table 15.—*Manila rope slings*

ROPE DIAMETER Nominal In Inches	Nominal Weight Per 100 ft In Pounds	Minimum Breaking Strength In Pounds	RATED CAPACITY IN POUNDS (Safety Factor = 5)													
			EYE AND EYE SLING						ENDLESS SLING							
			VERTICAL HITCH	CHOKER HITCH	BASKET HITCH				VERTICAL HITCH	CHOKER HITCH	BASKET HITCH					
					Angle of Rope to Horizontal						Angle of Rope to Horizontal					
					90 deg	60 deg	45 deg	30 deg			90 deg	60 deg	45 deg	30 deg		
					Angle of Rope to Vertical						Angle of Rope to Vertical					
					0 deg	30 deg	45 deg	60 deg			0 deg	30 deg	45 deg	60 deg		
1/2	7.5	2,650	550	250	1,100	900	750	550	950	500	1,900	1,700	1,400	950		
9/16	10.4	3,450	700	350	1,400	1,200	1,000	700	1,200	600	2,500	2,200	1,800	1,200		
5/8	13.3	4,400	900	450	1,800	1,500	1,200	900	1,600	800	3,200	2,700	2,200	1,600		
3/4	16.7	5,400	1,100	550	2,200	1,900	1,500	1,100	2,000	950	3,900	3,400	2,800	2,000		
13/16	19.5	6,500	1,300	650	2,600	2,300	1,800	1,300	2,300	1,200	4,700	4,100	3,300	2,300		
7/8	22.5	7,700	1,500	750	3,100	2,700	2,200	1,500	2,800	1,400	5,600	4,800	3,900	2,800		
1	27.0	9,000	1,800	900	3,600	3,100	2,600	1,800	3,200	1,600	6,500	5,600	4,600	3,200		
1 1/16	31.3	10,500	2,100	1,100	4,200	3,600	3,000	2,100	3,800	1,900	7,600	6,600	5,400	3,800		
1 1/8	36.0	12,000	2,400	1,200	4,800	4,200	3,400	2,400	4,300	2,200	8,600	7,500	6,100	4,300		
1 1/4	41.7	13,500	2,700	1,400	5,400	4,700	3,800	2,700	4,900	2,400	9,700	8,400	6,900	4,900		
1 5/16	47.9	15,000	3,000	1,500	6,000	5,200	4,300	3,000	5,400	2,700	11,000	9,400	7,700	5,400		
1 1/2	59.9	18,500	3,700	1,850	7,400	6,400	5,200	3,700	6,700	3,300	13,500	11,500	9,400	6,700		
1 5/8	74.6	22,500	4,500	2,300	9,000	7,800	6,400	4,500	8,100	4,100	16,000	14,000	11,500	8,000		
1 3/4	89.3	26,500	5,300	2,700	10,500	9,200	7,500	5,300	9,500	4,800	19,000	16,500	13,500	9,500		
2	107.5	31,000	6,200	3,100	12,500	10,500	8,800	6,200	11,000	5,600	22,500	19,500	16,000	11,000		
2 1/8	125.0	36,000	7,200	3,600	14,500	12,500	10,000	7,200	13,000	6,500	26,000	22,500	18,500	13,000		
2 1/4	146.0	41,000	8,200	4,100	16,500	14,000	11,500	8,200	15,000	7,400	29,500	25,500	21,000	15,000		
2 1/2	166.7	46,500	9,300	4,700	18,500	16,000	13,000	9,300	16,500	8,400	33,500	29,000	23,800	16,500		
2 5/8	190.8	52,000	10,500	5,200	21,000	18,000	14,500	10,500	18,500	9,500	37,500	32,500	26,500	18,500		

Appendix BB (CONTINUED)

Table 16.—*Nylon rope slings*

ROPE DIAMETER Nominal In Inches	Nominal Weight Per 100 ft In Pounds	Minimum Breaking Strength In Pounds	RATED CAPACITY IN POUNDS (Safety Factor = 9)											
			EYE AND EYE SLING						ENDLESS SLING					
			VERTICAL HITCH	CHOKER HITCH	BASKET HITCH				VERTICAL HITCH	CHOKER HITCH	BASKET HITCH			
					Angle of Rope to Horizontal						Angle of Rope to Horizontal			
					90 deg	60 deg	45 deg	30 deg			90 deg	60 deg	45 deg	30 deg
					Angle of Rope to Vertical						Angle of Rope to Vertical			
					0 deg	30 deg	45 deg	60 deg			0 deg	30 deg	45 deg	60 deg
1/2	6.5	6,080	700	350	1,400	1,200	950	700	1,200	600	2,400	2,100	1,700	1,200
9/16	8.3	7,600	850	400	1,700	1,500	1,200	850	1,500	750	3,000	2,600	2,200	1,500
5/8	10.5	9,880	1,100	550	2,200	1,900	1,600	1,100	2,000	1,000	4,000	3,400	2,800	2,000
3/4	14.5	13,490	1,500	750	3,000	2,600	2,100	1,500	2,700	1,400	5,400	4,700	3,800	2,700
13/16	17.0	16,150	1,800	900	3,600	3,100	2,600	1,800	3,200	1,600	6,400	5,600	4,600	3,200
7/8	20.0	19,000	2,100	1,100	4,200	3,700	3,000	2,100	3,800	1,900	7,600	6,600	5,400	3,800
1	26.0	23,750	2,600	1,300	5,300	4,600	3,700	2,600	4,800	2,400	9,500	8,200	6,700	4,800
1 1/16	29.0	27,360	3,000	1,500	6,100	5,300	4,300	3,000	5,500	2,700	11,000	9,500	7,700	5,500
1 1/8	34.0	31,350	3,500	1,700	7,000	6,000	5,000	3,500	6,300	3,100	12,500	11,000	8,900	6,300
1 1/4	40.0	35,625	4,000	2,000	7,900	6,900	5,600	4,000	7,100	3,600	14,500	12,500	10,000	7,100
1 5/16	45.0	40,850	4,500	2,300	9,100	7,900	6,400	4,500	8,200	4,100	16,500	14,000	12,000	8,200
1 1/2	55.0	50,350	5,600	2,800	11,000	9,700	7,900	5,600	10,000	5,000	20,000	17,500	14,000	10,000
1 5/8	68.0	61,750	6,900	3,400	13,500	12,000	9,700	6,900	12,500	6,200	24,500	21,500	17,500	12,500
1 3/4	83.0	74,100	8,200	4,100	16,500	14,500	11,500	8,200	15,000	7,400	29,500	25,500	21,000	15,000
2	95.0	87,400	9,700	4,900	19,500	17,000	13,500	9,700	17,500	8,700	35,000	30,500	24,500	17,500
2 1/8	108.0	100,700	11,000	5,600	22,500	19,500	16,000	11,000	20,000	10,000	40,500	35,000	28,500	20,000
2 1/4	120.0	118,750	13,000	6,600	26,500	23,000	18,500	13,000	24,000	12,000	47,500	41,000	33,500	24,000
2 1/2	149.0	132,000	15,000	7,400	29,500	25,500	21,000	15,000	26,500	13,500	53,000	46,000	37,500	26,500
2 5/8	168.0	153,900	17,100	8,600	34,000	29,500	24,000	17,000	31,000	15,500	61,500	53,500	43,500	31,000

Appendix BB (CONTINUED)

Table 17.—*Polyester rope slings*

ROPE DIAMETER Nominal In Inches	Nominal Weight Per 100 ft In Pounds	Minimum Breaking Strength In Pounds	RATED CAPACITY IN POUNDS (Safety Factor 9)											
			EYE AND EYE SLING						ENDLESS SLING					
			VERTICAL HITCH	CHOKER HITCH	BASKET HITCH				VERTICAL HITCH	CHOKER HITCH	BASKET HITCH			
					Angle of Rope to Horizontal						Angle of Rope to Horizontal			
					90 deg	60 deg	45 deg	30 deg			90 deg	60 deg	45 deg	30 deg
					Angle of Rope to Vertical						Angle of Rope to Vertical			
					0 deg	30 deg	45 deg	60 deg			0 deg	30 deg	45 deg	60 deg
1/2	8.0	6,080	700	350	1,400	1,200	950	700	1,200	600	2,400	2,100	1,700	1,200
9/16	10.2	7,600	850	400	1,700	1,500	1,200	850	1,500	750	3,000	2,600	2,200	1,500
5/8	13.0	9,500	1,100	550	2,100	1,800	1,500	1,100	1,900	950	3,800	3,300	2,700	1,900
3/4	17.5	11,875	1,300	650	2,600	2,300	1,900	1,300	2,400	1,200	4,800	4,100	3,400	2,400
13/16	21.0	14,725	1,600	800	3,300	2,800	2,300	1,600	2,900	1,500	5,900	5,100	4,200	2,900
7/8	25.0	17,100	1,900	950	3,800	3,300	2,700	1,900	3,400	1,700	6,800	5,900	4,800	3,400
1	30.5	20,900	2,300	1,200	4,600	4,000	3,300	2,300	4,200	2,100	8,400	7,200	5,900	4,200
1 1/16	34.5	24,225	2,700	1,300	5,400	4,700	3,800	2,700	4,800	2,400	9,700	8,400	6,900	4,800
1 1/8	40.0	28,025	3,100	1,600	6,200	5,400	4,400	3,100	5,600	2,800	11,000	9,700	7,900	5,600
1 1/4	46.3	31,540	3,500	1,800	7,000	6,100	5,000	3,500	6,300	3,200	12,500	11,000	8,900	6,300
1 5/16	52.5	35,625	4,000	2,000	7,900	6,900	5,600	4,000	7,100	3,600	14,500	12,500	10,000	7,100
1 1/2	66.8	44,460	4,900	2,500	9,900	8,600	7,000	4,900	8,900	4,400	18,000	15,500	12,500	8,900
1 5/8	82.0	54,150	6,000	3,000	12,000	10,400	8,500	6,000	11,000	5,400	21,500	19,000	15,500	11,000
1 3/4	98.0	64,410	7,200	3,600	14,500	12,500	10,000	7,200	13,000	6,400	26,000	22,500	18,000	13,000
2	118.0	76,000	8,400	4,200	17,000	14,500	12,000	8,400	15,000	7,600	30,500	26,500	21,500	15,000
2 1/8	135.0	87,400	9,700	4,900	19,500	17,000	13,500	9,700	17,500	8,700	35,000	30,500	24,500	17,500
2 1/4	157.0	101,650	11,500	5,700	22,500	19,500	16,000	11,500	20,500	10,000	40,500	35,000	29,000	20,500
2 1/2	181.0	115,900	13,000	6,400	26,000	22,500	18,000	13,000	23,000	11,500	46,500	40,000	33,000	23,000
2 5/8	205.0	130,150	14,500	7,200	29,000	25,000	20,500	14,500	26,000	13,000	52,000	45,000	37,000	26,000

Appendix BB (CONTINUED)

Table 18.—*Polypropylene rope slings*

ROPE DIA-METER Nominal In Inches	Nominal Weight Per 100 ft In Pounds	Minimum Breaking Strength In Pounds	RATED CAPACITY IN POUNDS (Safety Factor = 6)											
			EYE AND EYE SLING						ENDLESS SLING					
			VERTICAL HITCH	CHOKER HITCH	BASKET HITCH				VERTICAL HITCH	CHOKER HITCH	BASKET HITCH			
					Angle of Rope to Horizontal						Angle of Rope to Horizontal			
					90 deg	60 deg	45 deg	30 deg			90 deg	60 deg	45 deg	30 deg
					Angle of Rope to Vertical						Angle of Rope to Vertical			
					0 deg	30 deg	45 deg	60 deg			0 deg	30 deg	45 deg	60 deg
1/2	4.7	3,990	650	350	1,300	1,100	950	650	1,200	600	2,400	2,100	1,700	1,200
9/16	6.1	4,845	800	400	1,600	1,400	1,100	800	1,500	750	2,900	2,500	2,100	1,500
5/8	7.5	5,890	1,000	500	2,000	1,700	1,400	1,000	1,800	900	3,500	3,100	2,500	1,800
3/4	10.7	8,075	1,300	700	2,700	2,300	1,900	1,300	2,400	1,200	4,900	4,200	3,400	2,400
13/16	12.7	9,405	1,600	800	3,100	2,700	2,200	1,600	2,800	1,400	5,600	4,900	4,000	2,800
7/8	15.0	10,925	1,800	900	3,600	3,200	2,600	1,800	3,300	1,600	6,600	5,700	4,600	3,300
1	18.0	13,300	2,200	1,100	4,400	3,800	3,100	2,200	4,000	2,000	8,000	6,900	5,600	4,000
1 1/16	20.4	15,200	2,500	1,300	5,100	4,400	3,600	2,500	4,600	2,300	9,100	7,900	6,500	4,600
1 1/8	23.7	17,385	2,900	1,500	5,800	5,000	4,100	2,900	5,200	2,600	10,500	9,000	7,400	5,200
1 1/4	27.0	19,950	3,300	1,700	6,700	5,800	4,700	3,300	6,000	3,000	12,000	10,500	8,500	6,000
1 5/16	30.5	22,325	3,700	1,900	7,400	6,400	5,300	3,700	6,700	3,400	13,500	11,500	9,500	6,700
1 1/2	38.5	28,215	4,700	2,400	9,400	8,100	6,700	4,700	8,500	4,200	17,000	14,500	12,000	8,500
1 5/8	47.5	34,200	5,700	2,900	11,500	9,900	8,100	5,700	10,500	5,100	20,500	18,000	14,500	10,500
1 3/4	57.0	40,850	6,800	3,400	13,500	12,000	9,600	6,800	12,500	6,100	24,500	21,000	17,500	12,500
2	69.0	49,400	8,200	4,100	16,500	14,500	11,500	8,200	15,000	7,400	29,500	25,500	21,000	15,000
2 1/8	80.0	57,950	9,700	4,800	19,500	16,500	13,500	9,700	17,500	8,700	35,000	30,100	24,500	17,500
2 1/4	92.0	65,550	11,000	5,500	22,000	19,000	15,500	11,000	19,500	9,900	39,500	34,000	28,000	19,500
2 1/2	107.0	76,000	12,500	6,300	25,500	22,000	18,000	12,500	23,000	11,500	45,500	39,500	32,500	23,000
2 5/8	120.0	85,500	14,500	7,100	28,500	24,500	20,000	14,500	25,500	13,000	51,500	44,500	36,500	25,500

Appendix CC — CONTRACTOR'S SAFETY PROGRAM

Contractual agreement requires the prime contractor to submit for approval a safety program covering all aspects of the work. The submitted safety program must detail policies, procedures, and plans the contractor will implement to ensure the safety and health of employees including compliance with applicable requirements of "Construction Safety Standards," and the respective specifications paragraphs. The contractor should prepare a list of major hazards associated with the contract work and provide a written safety program to minimize the hazards as outlined in the following:

I. General Requirements

  A. Statement of Policy
  B. Statement of Safety and Health Responsibilities (Ref. section 2.8)
  C. Statement of Compliance with Regulations Standards and Codes (Ref. section 2.2)
  D. Statement of Subcontractor Compliance (Ref. section 2.3)
  E. Safety Inspection Procedures (Ref. section 2.9)
  F. Accident Investigation and Reporting Procedures (Ref. sections 2.10 and 2.11)
  G. Applicable Emergency Plans (Ref. section 6)
  H. Fire Protection Plans (Ref. section 10)

    I. Welding

II. Medical (Ref. section 4)

  A. Facilities
  B. Training (Ref. sections 3.4 and 4)
  C. Certifications (Ref. section 4)
  D. Physician (Ref. section 4)
  (Name, location, and telephone number)

Appendix CC (CONTINUED)

E. Ambulance (Ref. section 4)
(Name, location, and telephone number)
F. Physical Qualification of Employees (Ref. section 5)
G. Records (Ref. section 4)

III. Communications

A. Employee Indoctrination (Ref. section 3.1)
B. Safety Meetings (Ref. sections 2.7 and 3.3)
C. Onsite Training (Ref. section 3.2)
D. Supervisor Training (Ref. section 3.5)

IV. Occupational Health (Ref. section 7)

A. Procedures and Equipment to Minimize Hazards

1. Testing program for employees and work environments (Ref. sections 7.7.7 and 7.10.6)
2. Qualified personnel (Ref. sections 7.7.7, 7.8.3, 7.9.1, and 7.10.4)
3. Personal protective equipment (Ref. sections 7.7.7 and 8.5)
4. Ventilation plans (Ref. appendix DD)

V. Machinery and Mechanical Equipment (Ref. sestions 18, 19, 20, and 21)

A. Testing

1. Hoisting equipment (Ref. section 18.1.4)
2. Brakes (Ref. section 19.6.5)

B. Inspection Procedures (Ref. sections 19.3.2, and 18.1.5)
C. Maintenance Procedures (Ref. section 19.3)
D. Operating Personnel (Ref. sections 19.2.2, and 18.1.6)

Appendix CC (CONTINUED)

E. Protective Safety Devices (Ref. sections 18, and 19)

1. Certifications (Ref. sections 18.1.1, 18.7.3, and 19.6.3)

F. Elevators and Aerial Lifts (Ref. sections 10.10, and 18.2)

VI. Excavation and Demolition (Ref. sections 22, 23, and 30)

A. Tunnels

1. Internal combustion equipment certification (Ref section 23.6)
2. Ventilation plans (Ref. section 23.3)
3. Transportation plan (Ref. section 23.11)
4. Work environment testing (Ref. sections 23.4, 23.5, and 7.10.4)
5. Ground support (Ref. section 23.10)

B. Blasting (Ref. section 24)

1. Blaster certification (Ref. sections 24.1.2, 24.1.3, and 5.4)
2. Written procedures (Ref. section 24.1.9)
3. Storage (Ref. section 24.5)
4. Transportation (Ref. sections 24.3, and 24.4)

C. Trenching (Ref. section 22.3)

1. Sloping (Ref. section 22.2)
2. Shoring (Ref. section 22.2)
3. Inspections (Ref. sections 22.1, and 22.2)
4. Access (Ref. section 22.26)

D. High Scaling

1. Personal protective equipment (Ref. section 8)

Appendix CC (CONTINUED)

- E. Haulage (Ref. section 19.1)
  - 1. Haul road plans (Ref. section 19.1.2)

VII. Working Surfaces

- A. Access (Ref. section 14)
  - 1. Ladders
  - 2. Platforms, stairways, and ramps
- B. Personal Protective Equipment (Ref. section 8)
- C. Scaffolding (Ref. section 13)
- D. Safety Nets (Ref. section 8.10)

VIII. Protection of the Public (Ref. section 9)

- A. Signs and Barricades
- B. Flagging Procedures
- C. Jurisdictional Approvals

IX. Marine and Diving Operations (Ref. section 29)

- A. Detailed Plan and Written Procedures

X. Electrical Facilities

- A. Substations (Ref. section 28)
- B. Transmission Lines (Ref. section 27)

This outline is provided as guidance in preparing a safety program and does not cover all material that may be necessary. The contractor must review specifications and all safety and health regulations to ensure a comprehensive plan.

Appendix DD — TUNNEL VENTILATION DESIGN CRITERIA

The design criteria outlined below are considered essential to effective tunnel ventilation and exhaust and shall be covered in the contractor's ventilation plan for the approval of the Contracting Officer.

A. Preliminary design data

1. A layout of the tunnel heading showing positioning of equipment and personnel during drilling and mucking operations.

2. A line sketch showing:

a. Location of duct work and layout

b. Fan and collector locations

c. Method of obtaining adequate air volumes to the heading.

3. List diesel equipment to be used underground, a copy of the MSHA approval and schedule, and air volumes required.

B. Design data

1. Computations indicating air volumes and minimum duct velocities at 1,000-foot intervals from the tunnel portal or shaft heading. Calculation sheets are to be included in the data submitted.

2. All system losses are to be calculated, such as duct, elbows, transitional sections, cleanouts, collectors, and total head the system is to work against.

Appendix DD (CONTINUED)

3. Size and type of ducts, fan, hoods, pickup, and transfer configurations, transitional sections, cleanouts, etc., throughout the system. Include manufacturer's design specifications covering fans and motors; include fan curves.

4. Design and type of ventilation enclosures, curtains, pressure relief, doors, etc., are to be included.

5. Incude electrical wiring schematic indicating voltages, wattage, and characteristics of major electrical equipment, and system reversability from a surface location.

6. Utilize correction factors for altitude and mean temperature.

C. Testing. Indicate specifically how, where, and at what intervals air flow and/or pressure measurements will be made to ensure operation of the system. Instruments to be used and training of individual using such instruments, recordkeeping, etc., must be included.

D. Dust sampling. Indicate specific sampling strategy and plan to monitor airborne dust contaminants, instrumentation to be utilized, laboratory analysis, and competence/training of individual performing the sampling.

Appendix EE — GLOSSARY OF TERMS AND DEFINITIONS

Approved. A method, equipment, procedure, practice, tool, etc., which is sanctioned, consented to, confirmed, or accepted as good or satisfactory for a particular use or purpose by a person or organization authorized to render such approval or judgment.

Authorized person. A person approved or assigned by the employer to perform a specific type of duty or to assume a specific responsibility.

Certified or licensed. One who possesses a license or certificate issued by a recognized authority, attesting that he has been trained and/or tested and is competent and qualified in a specific field of endeavor.

Clearance. A statement with documentation from an authorized source declaring that specific electrical equipment and/or facilities have been deenergized and isolated from hazardous sources of energy.

Competent person. A person who by training and/or experience is capable of performing specifically assigned duties and responsibility. Further, he is capable of recognizing existing and predictable hazards or conditions which are unsanitary, hazardous, or dangerous, and is authorized to initiate prompt corrective action.

Confined space. Any space having a limited means of egress, which may be subject to the accumulation of toxic or flammable contaminants or an oxygen deficient atmosphere. Confined spaces include, but are not limited to, tunnels, shafts, storage tanks, silos, bins, process vessels, boilers, ducts, penstocks, scroll cases, galleries, vaults, pipelines, and conduits.

Contaminant. Any material which, by nature of its composition or reaction with other materials, is potentially capable of causing injury or illness to a person or persons.

Danger. A term denoting liability or potential to cause injury, death, illness, damage, loss, or pain.

Defect. Refers to any characteristic or condition which tends to weaken or reduce the strength of a material or object of which it is a part.

Designated person. Synonymous with "authorized person."

Engineer. One who, by possession of a recognized degree from an accredited college or a current engineering registration certificate, and who by knowledge, training, and experience, has successfully demonstrated the ability to design or analyze electrical, mechanical, hydraulic, or structural equipment and systems including their proper application.

Equipment. Any machine, device, or apparatus; electrical, mechanical, or hydraulic; including transmission lines, piping systems, and waterways.

First-aid attendant. A person who possesses a current certificate, issued by MESA or the American Red Cross, attesting to his or her competency in the administration of first aid to the injured or sick.

Hazard. A dangerous condition, potential or inherent, which can bring about an interruption or interfere with the expected orderly progress of an activity.

Hazardous condition. A physical condition or circumstance which is causally related to accident occurrence.

Hazardous substance or material. Refers to any substance which, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful, is likely to cause illness or injury.

High voltage. Refers to all voltages of 600 volts or greater, unless otherwise defined in the text of this manual.

Industrial hygienist. An individual who, by virtue of education, training, special studies, certification, and experience, has acquired competence in industrial hygiene. He is capable of recognizing the environmental factors, toxic chemicals, and stress of work operation, evaluating those factors based on experience and quantitative measurement techniques, and recommends methods to eliminate, control, or reduce such stresses.

Onsite construction operations. All construction activity performed under Bureau of Reclamation contract which are carried out within the confines of the project or construction site as specified in the contract document. It also includes all activities on property used by the contractor or his subcontractors, for the purpose of implementing work under the contract, i.e., borrow pits, repair shops, warehousing, equipment fabrication, and assembly sites, etc. The term does not apply to activities performed by established suppliers of materials or equipment to the construction industry.

Qualified. Refers to one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated ability to solve or resolve problems relating to the subject matter, the work, or the project.

Appendix EE (CONTINUED)

Radiation specialist (Health Physicist). An individual who, by virtue of education, training, certification, or experience, possesses the expertise necessary to develop and implement methods and procedures for the evaluation of radiation hazards and providing radiation protection to man and his environment.

Safe. Means relatively free from danger or hazard which could cause or result in injury, illness, or damage.

Safety factor. This refers to the ratio of the ultimate breaking strength of a member or piece of material or equipment to the actual working stress or safe working load when in use.

Scaffold grade. Lumber designated as suitable for scaffold planking by approved grading rules for the species of wood used. It shall be at leat 2 inches thick, knot free, with a minimum allowable horizontal shearing stress of 100 lb/in^2.

Suitable. That which fits and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance.

Safety professional or safety engineer. An individual who, by virtue of education, training, certification, and experience, has achieved professional status in the safety field.

Supervisor. A person held responsible for the behavior and production of a group of employees, usually refers to a construction foreman or superintendent.

Threshold limit values. The limit below which the effects of airborne substances cease to be perceptible and dangerous to employees who may be repeatedly exposed, day after day.

Toxic. Of, pertaining to, or caused by poison: poisonous, harmful.

Unsafe condition. Any physical state which deviates from that which is acceptable or correct in terms of its past production or potential future production of personal injury, illness, and/or damage to property. Also, any physical state which contributes to a reduction in the degree of safety normally present.

Appendix FF

REFERENCE MATERIAL

These references apply unless superseded by more current standards.

American Concrete Institute
Box 19150, Redford Station
22400 West Seven Mile Road
Detroit, Michigan 48219

Publication SP4, "Formwork for Concrete"

American Conference of Governmental Industrial Hygienists
Box 1937
Cincinnati, Ohio 45201

Industrial Ventilation

Threshold Limit Values of Airborne Contaminants

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment

American Lumbering Standards Committee
20010 Century Boulevard, Suite 204
Germantown, Maryland 20767

American Lumbering Standards

American National Standards Institute
1430 Broadway
New York, New York 10018

A10.3 "Safety Requirements for Powder Actuated Fastening System"

A10.4 "Safety Requirements for Personnel Hoists"

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A10.5	"Safety Requirements for Material Hoists"
A.10.6	"Safety Requirements for Demolition"
A10.8	"Safety Requirements for Scaffolding"
A10.9	"Safety Requirements for Concrete Construction and Masonry Work"
A10.14	"Requirements for Safety Belts, Harnesses, Lanyards, Lifelines, and Drop Lines for Construction and Industrial Use"
A10.15	"Safety Requirements for Dredging"
A11.1	"Practice for Industrial Lighting"
A14.1	"Safety Requirements for Portable Wood Ladders"
A14.2	"Safety Requirements for Portable Metal Ladders"
A14.3	"Safety Requirements for Fixed Ladders"
A14.4	"Safety Requirements for Job-Made Ladders"
A17.1	"Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks"
A17.2	"Practice for the Inspection of Elevators, Escalators, and Moving Walks"
A92.2	"Vehicle Mounted Elevating and Rotating Work Platforms"
A120.1	"Safety Code for Powered Platforms for Exterior Building Maintenance"

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B7.1	"Safety Code for the Use, Care, and Protection of Abrasive Wheels"
B15.1	"Safety Standard for Mechanical Power Transmission Apparatus"
B20.1	"Safety Standards for Conveyors and Related Equipment"
B30.2	"Safety Code for Overhead and Gantry Cranes"
B30.4	"Safety Standard for Portal, Tower, and Pillar Cranes"
B30.5	"Safety Code for Crawler, Locomotive, and Truck Cranes"
B30.6	"Safety Code for Derricks"
B30.8	"Safety Code for Floating Cranes and Floating Derricks"
B30.9	"Safety Standard for Slings"
B31.1	"Power Piping"
B56.1	"Safety Standard for Powered Industrial Trucks - Low Lift and High Lift Trucks"
C1	"National Electrical Code"
C2	"National Electrical Safety Code"
C33.2	"Safety Standard for Transformer-type Arc-welding Machines"
C95.2	"Radio Frequency Radiation Hazard Warning Symbol"

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C95.4	"Safety Guide for the Prevention of Radio Frequency Radiation Hazards on the Use of Electric Blasting Caps"
D6.1	"Manual on Uniform Traffic Control Devices for Streets and Highways"
J6	"Specification for Rubber Protective Equipment for Electrical Workers"
J6.1	"Rubber Insulating Line Hose"
J6.2	"Rubber Insulating Hoods"
J6.4	"Rubber Insulating Blankets"
J6.5	"Rubber Insulating Sleeves"
J6.6	"Rubber Insulating Gloves"
J6.7	"Rubber Matting for Use Around Electrical Apparatus"
N2.1	"Radiation Symbol"
01.1	"Safety Requirements for Woodworking Machinery"
S1.4	"Specification for Sound Level Meters"
S3.19	(Formerly 224.22) "Method for the Measurement of Real-Ear Protection of Hearing Protectors and Physical Attenuation of Earmuffs"
Z35.1	"Specifications for Accident Prevention Signs"
Z35.2	"Specifications for Accident Prevention Tags"

Z35.2 "Safety Footwear"

Z49.1 "Safety in Welding and Cutting"

Z53.1 "Safety Color Code for Marking Physical Hazards"

Z87.1 "Practice for Occupational and Educational Eye and Face Protection"

Z88.2 "Practices for Respiratory Protection"

Z89.1 "Safety Requirements for Industrial Head Protection"

Z89.2 "Safety Requirements for Industrial Protective Helmets for Electrical Workers, Class B"

American Petroleum Institute
2101 L Street
Washington, D.C. 20037

American Petroleum Institute Standards

American Plywood Association
1119 A Street
Tacoma, Washington 98401

Group BB, Group 1, Exterior

(Plywood Products Standard PSI-74)

American Society of Mechanical Engineers
345 East 47th Street
New York, New York 10017

Boiler Construction Code (Combined edition)

Appendix FF (CONTINUED)

ASME Code for Unfired Pressure Vessels

American Welding Society
2501 NW Seventh Street
Miami, Florida 33125

B3.0 "Welding Procedures and Performance Qualifications"

D1.1 "Structural Welding Code"

D8.4 "Recommended Practices for Automotive Welding Design"

D10.4 "Standards for Qualification of Welding Procedures and Welders for Piping and Tubing"

"Safe Practice for Welding and Cutting Containers that Have Had Combustibles" (Pamphlet)

Construction Safety Association of Ontario
74 Victoria Street
Toronto, Ontario
Canada M5C 2A5

"Crane Handbook"

"Rigging Manual" - Designated as "Bureau Rigging Manual"

E.I. du Pont DeNemours & Company (Inc.)
Technical Service Section
Explosives Products Division
Wilmington, Delaware 19898

"Blasters' Handbook" (16th edition or later)

Appendix FF (CONTINUED)

Factory Mutual System

Factory Mutual Standards

Factory Mutual Laboratories

Factory Mutual Engineering

Federal Specifications

QQ-P-416 "Plating, Cadmium (Electrodeposited)"

RR-S-001302 "Safety Equipment, Climbing"

Institute of Makers of Explosives
420 Lexington Avenue
New York, New York 10017

National Electric Manufacturers Association

"Electric Arc Welding Machine Standards"

National Fire Protection Association
470 Atlantic Avenue
Boston, Massachusetts 02210

NFPA No. 10 - "Standard for Portable Fire Extinguishers"

NFPA No. 13 - "Standard for the Installation of Sprinkler System"

NFPA No. 30 - "Flammable and Combustible Liquids Code"

NFPA No. 31 - "Standard for the Installation of Oil Burning Equipment"

NFPA No. 33 - "Standard for Spray Application Using Flammable and Combustible Materials"

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NFPA No. 58 - "Storage and Handling Liquefied Petroleum Gases"

NFPA No. 70 - "National Electrical Code" (NEC)

NFPA No. 101 - "Life Safety Code"

NFPA No. 251 - "Standard Methods of Fire Tests of Building Construction and Materials"

NFPA No. 385 - "Tanks Vehicles for Flammable and Combustible Liquids"

NFPA No. 493 - "Standard for Intrinsically Safe Apparatus in Class I Hazardous Locations and Its Associated Apparatus"

Power Crane and Shovel Association (PCSA)
A Bureau of Construction Industry Manufacturers Association
Marine Plaza, Suite 1700
111 East Wisconsin Avenue
Milwaukee, Wisconsin 53202

PCSA Standard No. 2 "Mobile Hydraulic Crane Standards"

Reclamation, Bureau of

Form 7-1920 - "Brake Performance Test Record"
Form 7-1801 - "Record of Inspection and Test - Cranes and Hoisting Equipment"

Power O&M Bulletin No. 26 - "Power System Clearance Procedure"

"Power System Safety Standards"

Appendix FF (CONTINUED)

Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, Pennsylvania 15096

J167a - "Overhead Protection for Agriculture Tractors - Test Procedures and Performance Requirements"

J321a - "Fenders for Pneumatic-Tired Earthmoving Haulage Equipment"

J333b - "Operator Protection for Wheel-type Agricultural Tractors"

J334b - "Protective Frame for Agricultural Tractors - Test Procedures and Performance Requirements"

J386a - "Seatbelts for Construction Equipment"

J397a - "Deflection Limiting Volume for Laboratory Evaluation of Rollover Protective Structures (ROPS) and Falling Object Protective Structures (FOPS) of Construction and Industrial Vehicles"

J429h - "Mechanical and Material Requirement for Externally Threaded Fasteners"

J743a - "Tractor Mounted Side Booms"

J995c - "Mechanical and Material Requirements for Steel Nuts"

J1026 - "Minimum Performance Criteria for Braking Systems for Crawler Tractors and Crawler Loaders"

J1040a - "Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines"

Appendix FF (CONTINUED)

J1041 - "Brake Test Procedure and Brake Performance Criteria for Agricultural Equipment"

J1136 - "Minimum Performance Criteria for Braking Systems for Self-Propelled, Smooth Steel Wheel, Pneumatic Tired or Multiple Projection Steel Wheel Rollers and Compactors"

J1152 - "Minimum Performance Criteria for Braking Systems for Off-Highway, Rubber-Tired, Self-Propelled Construction Machines"

Underwriters Laboratories, Inc.
207 East Ohio Street
Chicago, Illinois 60611

U.S. Department of Labor

Mine Safety and Health Administration

U.S. Bureau of Mines - Schedule 24, Schedule 30, Schedule 31, Circulars 5616 and 8183

Report of Investigations RI-5616

Occupational Safety and Health Administration

PL 91-596, OSHA Act of 1970, Section 19, "Federal Agency Safety Program and Responsibilities"

29 CFR 1910, Chapter XVII, Subpart T - "Commercial Diving Operations"

29 CFR 1910.1001, "Asbestos"

29 CFR 1926, "Safety and Health Regulations for Construction"

Appendix FF (CONTINUED)

29 CFR 1926.104, "Safety Belts, Lifelines, and Lanyards"

29 CFR 1910.145, "Specifications for Accident Prevention Signs and Tags"

29 CFR 1926.153, "Liquefied Petroleum Gas (LP-Gas)"

29 CFR 1926.200, "Accident Prevention Signs"

Figure G-1, page 60

Figure G-2, page 60

29 CFR 1926, 251, "Rigging Equipment for Material Handling"

Table H-1

Tables H-1 through H-18

Tables H-3 through H-14

29 CFR 1926.803, "Compressed Air"

29 CFR 1926, Subpart U, "Blasting and the Use of Explosives"

29 CFR 1926,959, "Lineman's Body Belts, Safety Straps, and Lanyards"

U.S. Department of Transportation

Coast Guard

46 CFR Parts 146-149, "Dangerous Cargoes"

Federal Aviation Administration

Appendix FF (CONTINUED)

Federal Highway Administration

49 CFR Parts 390-397, "Federal Motor Carrier Safety Regulations"

Materials Transportation Bureau

49 CFR Parts 171-179, "Hazardous Materials Regulations," (including 49 CFR Part 178, "Shipping Container Specifications")

49 CFR Part 195, "Transportation of Liquids by Pipelines"

National Highway Traffic Safety Administration

49 CFR 571, "Federal Motor Vehicles Safety Standards"

U.S. Department of the Treasury

Bureau of Alcohol, Tobacco, and Firearms

27 CFR 181 "Commerce in Explosives"

U.S. Navy

U.S. Navy Standard Depression Tables

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Standards for Protection Against Radiation

Title 10, Chapter I, CFR Part 20 - Standards for Protection Against Radiation

Appendix GG — METRIC CONVERSION FACTORS

The following SI metric conversion factors are presented to facilitate conversion of the U.S. customary (inch-pound) units of measure presented in this manual.[1,2]

Length

1 inch = 25.4 millimeters

1 foot = 304.8 mm

1 yard = 0.9144 meter

Area

1 square inch = 6.45 square centimeters

1 square foot = 929.03 square centimeters

Volume/Capacity

---

[1] Nominal conversions: for noncritical dimensions, nominal conversion factors may be used. Examples of this are:

1 inch = 25 millimeters:

1 foot = 300 millimeters

1 yard = 1 meter

1 lb/in^2 = 7 kPa

[2] Converting maximum/minimum dimensions: To ensure exact compliance with stated maximum or minimum dimensions, dimensions converted to metric units shall be rounded in the conservative direction, i.e., maximum values should be rounded downward and minimum values should be rounded upward.

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1 cubic inch = 16.39 cubic centimeters

1 quart = 0.946 liter

1 gallon = 3.785 liters

Velocity

1 mile per hour = 1.61 kilometers per hour

1 foot per minute = 10.3048 meters per minute

Mass

1 pound = 0.454 kilogram

Force

1 pound = 4.45 newtons

Light Intensity

1 footcandle = 10.76 lux

Flow

1 gallon per minute = 3.785 liters per minute

Power

1 horsepower = 746 watts

Appendix GG (CONTINUED)

Temperature

$$t\ (^\circ C) = \frac{5}{9}\left[t\ (^\circ F) - 32\right]$$

Pressure

1 pound per square inch = 6.89 kilopascals

1 pound per square foot = 0.048 kilopascal

Loadings, mass

$1\ lb/ft^2$ = 4.88 kilograms per square meter

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